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7.3 WATER USE AFFECTED ENVIRONMENT

This section describes water use in the Middle Fork American River Watershed (Watershed), as it relates to Placer County Water Agency's (PCWA) Middle Fork American River Project (MFP or Project).

Information on water quality is presented in Section 7.4 – Water Quality Affected Environment (seasonal physical and chemical water quality data and federally-approved water quality standards) and Section 7.5 – Fish and Aquatics Resources Affected Environment (stream and reservoir water temperature and dissolved oxygen data, including reservoir profiles). A description of the beneficial uses associated with the MFP is provided in Section 7.1 – General Description of the River Basin. Information on MFP operations including uses of Project waters, existing Federal Energy Regulatory Commission (FERC or Commission) license conditions, existing operating agreement/contracts, existing water rights, and water rights applications is provided in Section 3.0 – No-Action Alternative.

The following presents information on water use including:

- Description of the Watershed;
- Overview of the MFP;
- Existing Stream and Reservoir Gages;
- Hydrology Data Development; and
- Summary of Project Hydrology.

7.3.1 Information Sources and Key Information

Existing information regarding water use in the vicinity of the MFP was collected, reviewed, and evaluated. Relevant information used to prepare this section included the following reports and data sources:

- Pre-Application Document (PAD) for the Middle Fork American River Project (PCWA 2007a). The PAD includes a general description of the Watershed, including climate and precipitation, runoff, and air temperature. The PAD also contains information on existing gaging stations and includes detailed summaries of the impaired and unimpaired hydrology for bypass and peaking reaches associated with the MFP.

- 2005–2006 Hydrology Study Status Report (PCWA 2007b). This report includes information on existing gaging stations in the vicinity of the MFP and the development of the hydrology data for the relicensing studies.

- REC 4 – Stream-based Recreation Opportunity Technical Study Report (PCWA 2010; Supporting Document [SD] B). Bypass and peaking reach flows are summarized in this report.

7.3.2 Description of the Watershed

The MFP is situated in the foothills and mountainous uplands of the western slope of the central Sierra Nevada, primarily within Placer County. The Project is almost entirely in the Tahoe and Eldorado National Forests, with a small portion on PCWA-owned property. The MFP facilities are located on the Middle Fork American River, the Rubicon River, Duncan Creek, and the North and South forks of Long Canyon Creek, within an area referred to as the Middle Fork American River watershed. Table 7.3-1 summarizes information on the streams and rivers associated with the MFP including drainage area, stream lengths, and stream gradients. Section 7.1 – General Description of the River Basin provides a general description of the Watershed.

7.3.2.1 Climate and Precipitation

The Watershed is characterized by hot, dry summers and mild, wet winters, with most of the precipitation falling between October and March. Precipitation falls as rain in the lower elevations and snow at elevations greater than 5,000 feet mean sea level (msl). Elevations higher than about 6,000 feet msl typically are covered with snow until May. Mean annual precipitation in the Watershed ranges from approximately 35 inches in dry years to 94 inches in wet years.

Precipitation and snowfall accumulation are recorded in the vicinity of the MFP through a network of monitoring and recording stations operated by numerous entities, including the National Weather Service, California Department of Forestry (CDF), United States Department of Agriculture-Forest Service (USDA-FS), United States Bureau of Reclamation (USBR), and PCWA. Measurements are collected at higher elevations near Duncan Creek (7,100 feet) down to the lower elevations near Folsom Dam (350 feet). Real-time and historical rainfall and snowfall data are available on the California Data Exchange Center website (http://cdec.water.ca.gov).

7.3.2.2 Runoff

The amount of runoff derived from rainfall and snowmelt can vary greatly. Occasionally, very intense and localized winter rainstorms result in substantial runoff. The typical snowmelt period, when runoff and stream flows are high, is April through mid-June. Snowmelt runoff can occur earlier in drier years and last longer during wetter years.

Total MFP inflow (combined flows from Duncan Creek, Middle Fork American River, Rubicon River, and Long Canyon Creek) for the period 1975 to 2007 averaged approximately 379,015 ac-ft and ranged from a low of approximately 62,638 ac-ft to a high of more than 790,820 ac-ft (more than a tenfold difference). Annual inflow into the Project reservoirs and diversions is also discussed in Section 3.0 – No-Action Alternative.

7.3.2.3 Air Temperature

Air temperatures range from highs over 100 degrees Fahrenheit (°F) during the summer months to lows below freezing during the winter in the higher elevations. In the lower elevations, summer high temperatures can reach 100°F or more, and typically range between 87°F and 94°F. During the winter, high temperatures typically range between 46°F and 54°F. Temperatures decrease about 3°F and precipitation increases by about 10 inches for every 1,000-foot increase in elevation (USBR 1992). Summer temperatures in the Watershed are moderated by winds from the south or southwest, originating in the Sacramento/San Joaquin Delta. These winds can cool temperatures by 10°F to 20°F.

7.3.3 Overview of the MFP

The MFP is owned and operated by PCWA and is a multi-purpose water supply and hydroelectric generation project designed to control and conserve waters of the Middle Fork American River, Duncan Creek, Rubicon River, Long Canyon Creek, and their respective upstream tributaries. The Project is operated with respect to four primary objectives: (1) meet FERC license requirements that protect environmental resources and provide for recreation; (2) meet PCWA's consumptive water demand obligations; (3) generate power to help meet California's energy demand and provide valuable support services required to maintain the overall quality and reliability of the state's electrical supply system; and (4) maintain Project facilities to ensure their availability and reliability. Construction of MFP facilities began in 1963 following issuance of the FERC License and the operations began in 1967 upon completion of construction activities.

The MFP includes two large dams and principal water storage reservoirs, French Meadows and Hell Hole, which have a combined gross storage of 342,583 ac-ft. In addition, the MFP includes: two medium dams and reservoirs, Middle Fork Interbay (gross storage of 175 ac-ft) and Ralston Afterbay (gross storage of 2,782 ac-ft); and three small dams and diversion pools, Duncan Creek, and North Fork and South Fork Long Canyon creeks. The Project facilities are located at elevations ranging from approximately 5,300 feet msl at Duncan Creek Diversion to approximately 1,100 feet msl at Ralston Afterbay. Maps and an elevation profile of the Project facilities as well as information on the MFP diversion facilities are provided in Section 3.0 – No-Action Alternative.

7.3.4 Existing Stream and Reservoir Gages

PCWA currently maintains an extensive network of stream, powerhouse, and reservoir gaging stations in the Watershed to monitor and record the storage and flow of water. This network consists of 15 stations that measure flow in rivers, streams, and powerhouses, and six stations that measure reservoir elevation and storage on Project reservoirs (Section 3.0 – No-Action Alternative for descriptions of these gages). In addition to the gages maintained by PCWA, a number of other United States Geological Survey (USGS) stream and reservoir gages are present in the Middle Fork and North

Fork American River watersheds, including those associated with the Georgetown Divide Public Utility District's (GDPUD) Stumpy Meadows Reservoir and with Sacramento Municipal Utility District's (SMUD) Upper American River Project (UARP) (FERC Project No. 2101). The locations of gaging stations are shown on Map 7.3-1. These gages and those maintained by PCWA are described in PCWA's Pre-Application Document (PAD) (PCWA 2007a), SD B, Detailed Existing Project Description and SD G, 2005–2006 Hydrology Study Status Report (PCWA 2007b).

7.3.5 Hydrology Data Development

The hydrology information from existing gaging data and information available from the USGS and the California Data Exchange Center (CDEC), augmented by new data developed by PCWA, was initially reviewed for characterizing flow conditions in the MFP. Data developed by SMUD in association with the relicensing of the UARP was also compiled and evaluated, including calculations of unimpaired flows and accretions.

The existing hydrology information was limited and constrained the characterization of the existing and unimpaired hydrology in the bypass and peaking reaches associated with the MFP. Further, as the data were utilized to develop estimated unimpaired hydrology and accretion flows, errors, data gaps, and inaccurate data were identified. Accordingly, PCWA consulted with the resource agencies regarding various approaches that could be used to augment the existing data set. Using agreed upon methods, PCWA calculated accretion flows, filled in data gaps, and developed both impaired and unimpaired hydrology at numerous locations throughout the Watershed. The methods used to augment the existing hydrologic record and to develop the impaired and unimpaired hydrology are presented in detail in PCWA's 2005–2006 Hydrology Study Status Report (PCWA 2007b).

The historical empirical and synthetic hydrologic data (mean daily flow) are used to describe impaired and unimpaired flows at specific locations in the bypass and peaking reaches associated with the MFP. Flow data were calculated for a number of the sub-watersheds to account for accretion flows (Map 7.3-2). The locations are identified by a "node" or "arc" number. Data in the summary figures and tables are identified by USGS gage number and/or by the arc (beginning and ending node numbers) in Maps 7.3-1 and 7.3-2, respectively. In addition, 15-minute data are used to describe and analyze impaired flows in the peaking reach, as appropriate. The historical empirical hydrology and synthesized data used in the analyses are available for download on PCWA's website at: http://relicensing.pcwa.net/html/science/hydrology.php).

7.3.5.1 Period of Record

The period of record used to develop hydrology data for the bypass and peaking reaches extends from water year 1975 through water year 2007. This time period best represents the recent operation of the MFP since the issuance of the original FERC license. Records of diversions and stream flows are more complete after 1975. In addition, this period of record is consistent with the period of record used by SMUD during the relicensing of the UARP. Some of the hydrology developed for the UARP is used as part of PCWA's relicensing because SMUD's operations of the UARP upstream of the MFP on the Rubicon and South Fork Rubicon rivers affects water flows within the MFP. In the peaking reach, 15-minute data collected from 1988–2007 (excluding 1996) are used to describe and analyze impaired flows, as appropriate.

7.3.5.2 Water Year Types

The water year type classification used in the hydrology analysis is based on the predicted unimpaired inflow (runoff) to Folsom Reservoir from the spring forecast information provided by the California Department of Water Resources Bulletin 120. Bulletin 120 is published each month from February through May (DWR 2007).

The water year type classifications are based on review of the existing and unimpaired hydrologic record and are consistent with water year type classification used for the UARP. The proposed water year types for each year in the period for the hydrologic analyses for the MFP relicensing (WY 1975–2007) are shown in Tables 7.3-2a and b. During the period of record, based on inflow into Folsom Reservoir Figure 7.3-1, 30% of the years are classified as wet, 18% are above normal, 18% are below normal, 15% are dry, 15% are critical, and 3% are critical dry (based on the end-of-water-year-estimate).

7.3.5.3 Hydrology for Calculation of MFP Dependable Capacity

The hydrology data that were used to determine MFP dependable capacity was from the extreme critical water year of 1977 coincident with the period of peak summer power load, which historically occurs in July and August. The dependable capacity information for the MFP is provided in Table 3-4.

7.3.6 Summary of Project Hydrology

A detailed summary of the impaired and unimpaired hydrology for bypass and peaking reaches associated with the MFP is provided in the following four appendices included in PCWA's PAD (PCWA 2007a), SD F, Section 4.0 – Water Use, as follows:

- Appendix 4-C – This appendix includes tables summarizing mean monthly flows by water year for gaging stations and other locations in waters associated with the MFP.
- Appendix 4-D – This appendix includes tables summarizing annual peak discharges recorded at MFP gaging stations, by year.
- Appendix 4-E – This appendix includes graphs showing daily impaired and unimpaired flow at various locations in waters associated with the MFP.
- Appendix 4-F – This appendix includes tables summarizing hourly flows measured at the Middle Fork American River near Oxbow Powerhouse gage (November 1997 through May 31, 2006). In addition, it includes graphs showing hourly flows for Middle Fork American River near Oxbow Powerhouse

(October 1, 2002 to September 30, 2003) for Wet (1998), Below Normal (2003), to Dry (2001).

Additional comparisons and characterizations of hydrology in the peaking reach based upon empirically-collected 15-minute data are provided in REC 4 – Stream-based Recreation Opportunity Technical Study Report (PCWA 2010; SD B), as follows:

- Appendix N – This appendix includes plots summarizing: (1) impaired 15-minute flows for short time periods (April, July, and August/September) to show the shape and magnitude of the daily peaking events and the progression of peaking pattern from high spring flows to fall base flows; (2) daily peaking events during the late spring to early fall months (April to September) when peaking was most prominent in the hydrology; (3) an idealized characterization of peaking events (May to September); and (4) mean daily impaired and unimpaired flow data at the top, middle, and bottom of the peaking reach to illustrate the effects of accretion on the hydrology of the reach (e.g., accretion from the North Fork of the Middle Fork American River, the North Fork American River, and other tributaries).

The following subsections present an overview of hydrologic conditions in the bypass and peaking reaches under impaired (existing MFP operations) and estimated unimpaired (natural) conditions. To facilitate this discussion, summary hydrology data are presented in a series of figures for each reach representing five example water years including: 2006-wet, 1999-above normal, 2003-below normal, 2001-dry, and 1988-critical. These figures are provided in Appendix B1. Each figure includes impaired and unimpaired hydrology at the top and bottom of each reach to illustrate the effect of accretion on stream flow under existing MFP operations.

7.3.6.1 Bypass and Peaking Reaches Flows

In the bypass reaches, operations of the MFP produce two general patterns of flow alteration from the unimpaired (natural) pattern, depending on the size of the streams. In the large river bypass reaches, flows are altered all year long (Figure 7.3-2). In the smaller stream bypass reaches flows typically are altered only during the winter/spring season Figure 7.3-3. The hydrology data are summarized in Table 7.3-5 and includes the average, minimum, and maximum and 20%, 50%, and 80% exceedance impaired and unimpaired flows by month from 1975–2007 for locations in waters associated with the MFP. Monthly exceedance plots (20%, 50%, and 80%) under impaired and unimpaired flow conditions for each of these locations are provided in Figure 7.3-4.

Large River Bypass Reaches

The Rubicon River and the Middle Fork American River are large river bypass reaches. Example hydrographs showing impaired and unimpaired flows at the top, middle, and bottom of the Rubicon River and at the top and bottom of the Middle Fork American River and during different water years are provided in Appendix B1, Figures B1-1 through B1-15. The following describes seasonal changes in the MFP hydrology in the large river bypass reaches.

WINTER/SPRING SEASON

As shown on the hydrographs (Appendix B1, Figures B1-1 through B1-15), flows in the large river bypass reaches are typically reduced and more stable during the winter/spring season under impaired conditions than under unimpaired conditions because water is diverted from the reaches into storage for consumptive delivery and power generation. High flows in the large river bypass reaches that naturally occur during storm events and during the spring runoff season are typically captured in French Meadows or Hell Hole reservoirs. Currently, high flows in the upper end of these river reaches generally only occur when the reservoirs are spilling. Spills primarily occur in the wettest years and are typically lower in magnitude compared to natural high flows.

During the winter and spring periods, substantial accretion inflow may occur along the Rubicon River between Hell Hole Dam and Ralston Afterbay and along the Middle Fork American River between French Meadows Dam and Middle Fork Interbay. More accretion occurs during the wetter water years than during the drier water years. This accretion inflow, to some degree, restores the shape of the natural winter/spring hydrograph in the lower portions of these bypass reaches.

SUMMER/FALL SEASON

During the summer and fall season, flows in the Rubicon River and the Middle Fork American River are typically equal to or slightly higher than under natural conditions because water is released from storage to meet minimum instream flow requirements mandated in the existing FERC license.

Accretion flow during the summer/fall period is relatively small and has limited effect on the flow patterns in the large river bypass reaches. Accretion flow in the Middle Fork American River between Middle Fork Interbay Dam and Ralston Afterbay has less effect on the hydrology than occurs in the longer bypass reaches due to its limited watershed area.

Small Stream Bypass Reaches

Duncan Creek, North and South Fork Long Canyon Creeks, and Long Canyon Creek are small stream bypass reaches. Example hydrographs showing impaired and unimpaired flows at the top and bottom of each of these small stream bypass reaches during different water years are shown on Appendix B1, Figures B1-16 through B1-30. The following describes seasonal changes in the MFP hydrology in small stream bypass reaches.

WINTER/SPRING SEASON

As indicated on the hydrographs (Appendix B1, Figures B1-16 through B1-30), during the winter/spring season a portion of the flow in the small stream bypass reaches is diverted for storage and power generation during most water year types. Therefore, flows in the small stream bypass reaches during this time period are typically lower and more stable (less variation in flow volume) than natural flows. The exception occurs during winter storms or during spring runoff when flows often exceed the capacity of the diversion facilities, which results in a large portion of the flow passing downstream.

During the winter and spring period, accretion occurs along the Long Canyon Creek bypass reach (downstream of North and South Fork diversions) and in the Duncan Creek bypass reach and creates relatively natural shaped hydrographs in the lower portions of the reaches.

SUMMER/FALL SEASON

During the summer/fall season, the diversions are not operated because of low inflow and minimum instream flow requirements. Therefore, natural flow entering the diversion facilities is passed downstream into the bypass reaches. Accretion from tributary streams is typically minimal.

Peaking Reach

The peaking reach extends from Oxbow Powerhouse downstream to the high-water mark of Folsom Reservoir and includes two river segments: (1) the Middle Fork American River from Oxbow Powerhouse to the confluence of the North Fork American River; and (2) the North Fork American River from the confluence of the Middle Fork American River to the high-water mark of Folsom Reservoir.

Example hydrographs showing impaired and unimpaired flows at the top, middle, and bottom of the peaking reach during different water years are shown in Appendix B1, Figures B1-31 through B1-35.

The magnitude and timing of flows in the peaking reach are affected by releases from Oxbow Powerhouse. Oxbow Powerhouse is typically operated to follow daily power demand and to provide whitewater boating flows, and is not operated 24 hours per day (except in the wettest of water years and/or seasons of the year) leading to inter- and intra-daily flow fluctuations in the reach. Except during high-flow times of the year, releases from the Oxbow Powerhouse cause daily fluctuations in flows in the peaking reach of up to approximately 900 cfs (approximately 75 cfs to 1,025 cfs) (Figure 7.3-5).

Figure 7.3-6 shows idealized examples of peaking events in different months (May to September) by different water year types. The examples are based on an idealized unimodal peak, but frequently the daily events are more complicated and variable. Daily peaking duration can be short (a few hours) or long (most of the day). In addition, the magnitude of off-peak flow can vary and there can be multiple peaks and declines in flow over the day.

During the summer (June through Labor Day), Project operations at Oxbow Powerhouse are voluntarily modified to accommodate commercial whitewater boating. Commercial whitewater boating requires high flows (approximately 900+ cfs) for a minimum of approximately three hours beginning at approximately 9:00 AM to 10:00 AM. If normal peaking operations at Oxbow Powerhouse (based on power demand) are not projected to provide high-flow releases within the whitewater boating window (e.g., 9:00 AM to 12:00 PM), then the Oxbow Powerhouse release pattern is modified to accommodate whitewater boating. If Oxbow Powerhouse was operated solely to meet peak energy demand, then in drier years when limited water is available, high-flow releases would typically start several hours later in the day and high flows would not be released on some weekend days. The following first describes seasonal changes in the MFP hydrology, followed by a description of the longitudinal effect of daily peaking operations on the timing and shape of flow in the peaking reach.

WINTER/SPRING SEASON

During the winter/spring season, flows in the peaking reach can exceed 3,000 cfs due to natural runoff. Considerable accretion can occur along the length of the peaking reach, particularly during the winter period from the North Fork of the Middle Fork American River, Volcano Creek, Otter Creek, Canyon Creek, and North Fork American River watersheds. Mean daily unimpaired and 15-minute impaired flows at the top, middle, and bottom of the peaking reach to illustrate the effects of accretion flows during the winter/spring period are shown in Appendix B1, Figures B1-31 through B1-35.

In terms of high flows, the impaired and unimpaired flow patterns in the peaking reach are very similar during the winter. The primary effect of the MFP on flows in the peaking reach typically occurs in the late spring when snowmelt water from the headwaters is captured in the large upstream reservoirs.

SUMMER/FALL SEASON

During the summer season, flows in the peaking reach often consist of a daily peaking event starting from a low nighttime base flow (e.g., 100–200 cfs, being released from the Oxbow Powerhouse) followed by a morning up-ramp (approximately 250–450 cfs/hour) to a high peak flow of approximately 1,000 cfs and then an evening down-ramp (approximately 250–450 cfs/hour) back to the base flow. Each up-ramping and down-ramping period lasts for approximately two hours.

During the fall, the powerhouses are shut down for approximately a three- to six-week period for maintenance and flows in the peaking reach are held at a relatively steady flow close to, but greater than the 75 cfs minimum instream flow requirement. The duration of "low-flow" outage periods are highly variable from year-to-year and are independent of water year type. PCWA evaluated the MFP operations record and determined that outages occurred for an average of 23 days during the fall period. The analysis was limited to the period of September 1 through November 30, which is when most scheduled maintenance outages occur. During the period of record, two outages continued beyond this window (11/7/75–1/19/76 and 9/29/07–3/18/08).

FLOW TIMING VERSUS LOCATION IN THE PEAKING REACH

The time of day that water released from Oxbow Powerhouse arrives at downstream locations is dependent upon distance, the base flow present when ramping begins, and the peak flow reached during ramping. As shown on Figure 7.3-7, the lower the base flow prior to the peaking event, the slower the travel time. If the base flow is 100 cfs, water released from Oxbow Powerhouse travels at approximately 2.3 miles per hour (mph). If the base flow is 300 cfs, water released from Oxbow Powerhouse travels at approximately 2.8 mph. During typical summer operations (200 cfs base flow, 1000 cfs peak), the travel velocity of peaking pulse events is approximately 2.5 mph.

Distances between specific points in the peaking reach and water travel time between those points are summarized on Table 7.3-3. Table 7.3-4 shows the times flows would be at specific locations in the peaking reach given a specific starting time, in two hour increments. The information presented in both of these tables is based on a flow travel rate of 2.5 mph. As an example, flow released from Oxbow Powerhouse takes 8.9 hours to reach the trail crossing at Mammoth Bar, which is located 22.2 miles downstream. Accordingly, flow released from Oxbow Powerhouse at 8:00 AM doesn't reach Mammoth Bar until almost 5:00 PM.

SHAPE OF PEAKING FLOW CURVES

The shape of the peaking flow curve varies by time and location in the peaking reach. In general, the up-ramp from low-base flow to high-peaking flow, in terms of flow (e.g., change in cfs per hour) remains the same throughout the reach (Figure 7.3-8). The only variable that changes with regard to the up-ramp is the magnitude of stage change. The amount of stage change from base flow to the peak flow varies depending on the local slope and channel shape at any particular location in the reach. The total stage change for typical summer peaking events ranges from approximately 1 to 2.3 feet (average 1.8 feet), depending on location.

The duration of the peak is generally shortened by approximately one hour per 10 miles of travel distance downstream. The duration of the high-flow peak shortens with increasing downstream distance from Oxbow Powerhouse because water is stored in the stream channel as it moves downstream and reduces the total volume of the peak flow. For example, duration of the peak flow below Mammoth Bar, approximately 22.35 miles downstream of Oxbow Powerhouse, is shortened by approximately two hours, compared to the peak at Oxbow Powerhouse. At Fords Bar, which is 9.25 miles downstream of Oxbow Powerhouse, the duration of the peak is shortened on average by 56 minutes. Overall, the same amount of water from a peaking event at Oxbow Powerhouse must pass through downstream locations, but the shape (width of top and slope of down-ramp) of the curve is changed as the water released from Oxbow Powerhouse travels along the river.

The slope of the down-ramp also changes as the peak travels downstream. At the top of the reach, the down-ramps are relatively rapid with decreases in flow at a rate similar to the up-ramp rate (250–450 cfs/hour). As shown on Figure 7.3-8, down-ramps are slower and have a longer duration (slower down-ramp rate) depending on the distance down stream. This occurs because during the down-ramp the channel upstream of any particular location is full of water and must drain. The longer the length of channel upstream of any particular location in the peaking reach, the slower the down-ramp rate and the longer the down-ramp duration (i.e., the more channel there is to drain). For example, just downstream of Mammoth Bar (22.35 miles downstream of Oxbow Powerhouse), the down-ramp is at least three times slower than at Oxbow Powerhouse. A 900 cfs down-ramp below Mammoth Bar takes 9+ hours (about 100 cfs/hr) compared to about 3 hours at Oxbow Powerhouse. The six-hour difference occurs because the 22.35 miles of channel between Oxbow Powerhouse and Mammoth Bar is full of water that drains down to the base flow during the down-ramp.

7.3.6.2 Powerhouse Flows

During the filling period (winter and spring), flows through the MFP powerhouses are highly dependent on projected and actual runoff conditions. Flows through the powerhouses are used to manage the runoff to maximize water storage while minimizing spills. During the release period (summer and fall), after the reservoirs have reached their maximum storage capacity, monthly releases for generation are largely predictable for the remainder of the year. However, daily and hourly releases for generation, which respond to demand for electricity and electrical grid reliability, remain highly variable.

French Meadows Powerhouse generates electricity when water is moved from French Meadows Reservoir to Hell Hole Reservoir. It is nearly always operated in block loaded condition with the duration of the block of operation set depending on the volume of water to be moved. Hell Hole Powerhouse generates electricity opportunistically from flow releases from Hell Hole Dam. The Middle Fork and Ralston powerhouses, running in tandem, are often used to help maintain reliable operations of the state’s transmission grid by fine-tuning the flow of electricity in the grid to balance supply and demand. When operated to provide grid regulation, flow rates through the powerhouses vary quickly to meet constantly changing energy supply and demand conditions. These powerhouses are also frequently block loaded. When block loaded, flows through the powerhouses are usually set at an efficient operating level and run for a prescribed number of hours per day depending upon hydrology. Oxbow Powerhouse frequently runs in tandem with Middle Fork and Ralston powerhouses, and can utilize water supplied by Ralston Powerhouse, as well as inflow from the Middle Fork American and Rubicon rivers. Ralston Afterbay also has sufficient operational storage capacity to allow Oxbow Powerhouse to operate independently of Middle Fork and Ralston powerhouses for several hours at a time, depending on generation level. This independent operational flexibility is used to meet the ramping rate requirement downstream of Oxbow Powerhouse and to make releases for whitewater boating without requiring operation of the Middle Fork and Ralston powerhouses.

Additional information on water management and operation of the powerhouses is provided in Section 3.5.4. Table 7.3-5 and Figure 7.3-4 include exceedance flow statistics and monthly flow exceedance curves for French Meadows Powerhouse, Middle Fork Powerhouse, Ralston Powerhouse, and Oxbow Powerhouse.

7.3.6.3 Reservoir Storage

French Meadows and Hell Hole reservoirs have a combined gross storage of 342,583 ac-ft. Middle Fork Interbay and Ralston Afterbay on the Middle Fork American River contribute an additional 2,957 ac-ft combined gross storage (mostly in Ralston Afterbay). Table 7.3-6 provides information on MFP reservoirs including surface area, volume, maximum depth, mean depth, flushing rate, shoreline length, and substrate composition. The storage capacity curves for French Meadows Reservoir, Hell Hole Reservoir, Middle Fork Interbay, Ralston Afterbay, and Duncan Creek Diversion Pool are shown in Figures 7.3-9 through 7.3-13, respectively. Middle Fork Interbay is very small (175 ac-ft or less). It is typically held at full capacity and the storage volume changes due to periodic sedimentation infill and subsequent cleaning.

Water storage is managed in French Meadows and Hell Hole reservoirs to be at the lowest by the early winter to provide adequate carryover storage and to manage spring runoff (Figure 7.3-14). This drawdown must balance the objectives of providing sufficient storage space to minimize the potential for spilling the reservoirs if the following spring is wet, and retaining sufficient water in storage to ensure that an adequate supply of water to meet instream flow requirements and consumptive demands if the following spring is dry. Generally, the reservoirs have been operated to achieve a combined storage target of approximately 142,000 ac-ft on December 31 of each year. However, the carryover storage can be much higher following very wet years and much lower following very dry years. Targeting a carryover level of 142,000 ac-ft provides approximately 190,000 ac-ft of operational (empty) storage capacity that can be used to manage the winter and spring runoff. During spring runoff, operating flows are adjusted to store as much water as possible without spilling the reservoirs. Spills from French Meadows and Hell Hole reservoirs occurred during ten years between October 1, 1974 and September 30, 2007. The releases occurred both in the winter and in the spring. The spring flows were of relatively short durations and lower magnitudes compared to unimpaired flows conditions. After the reservoirs have reached their maximum capacity in late spring or summer, water is managed first to meet instream flow requirements, then to meet consumptive water supply requirements, and then to optimize power generation. The period-of-record flow data for the Middle Fork American River and Rubicon River and storage data for French Meadows and Hell Hole reservoirs are shown in Figure 7.3-15 (a and b).

Table 7.3-5 and Figure 7.3-4 include exceedance statistics and monthly storage duration curves for French Meadow and Hell Hole reservoirs. Ralston Afterbay and Middle Fork Interbay are primarily used as powerhouse forebays and afterbays, and not as storage reservoirs. Middle Fork Interbay water surface elevations typically remain near full pool. Ralston Afterbay water surface elevations typically remain within 8 feet of full pool. Ralston Afterbay water surface elevation typically fluctuates daily in the summer and early fall due to peaking operations of the MFP and whitewater boating releases. Both Middle Fork Interbay and Ralston Afterbay are lowered annually during the fall, for approximately three to six weeks, for maintenance. Flows are reduced in the Middle Fork American River below Oxbow Powerhouse and higher flows than the required minimum instream flows may also be released from Hell Hole Reservoir (and sometimes French Meadows Reservoir) during this time to ensure that the minimum instream flow requirement downstream of Oxbow Powerhouse is met.

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TABLES

Table 7.3-1. Information on Drainage Area, Stream Length, and Gradient of Waters Associated with the Middle Fork American River Project.

Stream Name	Total Sub-basin Area (mi^2)	Sub-divided Areas (mi^2)	Stream Length (mi)	Elevation (ft)	Average Stream Gradient (%)
Duncan Creek					
Duncan Creek – Headwaters to confluence with Middle Fork American River	23.5	-	14.1	Starting: 7045.0 Ending: 3365.6	5.0
Duncan Creek – Headwaters to Duncan Creek Diversion Dam	-	9.9	5.5	Starting: 7045.0 Ending: 5257.7	6.2
Duncan Creek – Duncan Creek Diversion Dam to confluence with Middle Fork American River	-	13.6	8.6	Starting: 5257.7 Ending: 3365.6	4.2
Middle Fork American River					
Middle Fork American River – Headwaters to confluence with the North Fork American River Confluence	184.5	-	62.3	Starting: 8268.1 Ending: 542.0	2.3
Middle Fork American River – Headwaters to French Meadows Reservoir Dam	-	47.0	15.1	Starting: 8268.1 Ending: 5084.2	4.0
Middle Fork American River – French Meadows Dam to Middle Fork Interbay	-	18.4	11.6	Starting: 5084.2 Ending: 2488.6	4.2
Middle Fork American River – Middle Fork Interbay Dam to Ralston Afterbay	-	22.8	10.8	Starting: 2488.6 Ending: 1158.1	2.3
Middle Fork American River – Ralston Afterbay Dam to confluence with North Fork American River	-	96.3	24.7	Starting: 1158.1 Ending: 542.0	0.5
Long Canyon Creek – Headwaters to confluence with Rubicon River	49.0	-	28.8	Starting: 6749.1 Ending: 1398.5	3.5
Long Canyon Creek – Confluence of North and South Forks of Long Canyon Creek to confluence with Rubicon River	-	31.3	11.4	Starting: 4119.8 Ending: 1398.5	4.5

Table 7.3-1. Information on Drainage Area, Stream Length, and Gradient of Waters Associated with the Middle Fork American River Project (continued).

Stream Name	Total Sub-basin Area (mi^2)	Sub-divided Areas (mi^2)	Stream Length (mi)	Elevation (ft)	Average Stream Gradient (%)
Middle Fork American River (continued)					
North Fork Long Canyon Creek	-	6.6	6.9	Starting: 6359.0 Ending: 4119.8	6.1
South Fork Long Canyon Creek	-	11.1	10.4	Starting: 6749.1 Ending: 4119.8	4.8
Rubicon River					
Rubicon River – Headwaters to Middle Fork American River	209.5	-	58.1	Starting: 8076.2 Ending: 1180.3	2.2
Rubicon River – Headwaters to Hell Hole Reservoir Dam	-	113.4	27.7	Starting: 8076.2 Ending: 4531.4	2.4
Rubicon River – Hell Hole Dam to Middle Fork American River	-	96.1	30.5	Starting: 4531.4 Ending: 1180.3	2.1
Other Major Streams in the Watershed					
South Fork Rubicon River – Headwaters to Confluence with Rubicon River	57.0	-	16.2	Starting: 7556.1 Ending: 3552.6	4.7
North Fork of Middle Fork American River – Headwaters to confluence with Middle Fork American River	92.5	-	18.8	Starting: 4373.3 Ending: 1069.9	3.3
North Fork American River– Confluence of Middle Fork American River to Folsom High Water Mark	5.5	-	4.0	Starting: 542.0 Ending: 491.1	0.2

Table 7.3-2a. Water Year Types[1] During the Period of Record (1975 to 2007).

Water Year Classification			33 Years Hydrology (1975 - 2007)				107 Years Hydrology (1901 - 2007)
			March Forecast	April Forecast	May Forecast	End-of-Water-Year-Estimate	End-of-Water-Year-Estimate
Proposed Action Water Year Class	No Action Water Year Class	Breakpoints, FUI, ac-ft	Number of Years (%)	Number of Years (%)	Number of Years (%)	Number of Years (%)	Number of Years (%)
Wet	Wet	>= 3,400,000	11 (33.3%)	10 (30.3%)	12 (36.4%)	10 (30.3%)	32 (29.9%)
Above Normal		>= 2,400,000	4 (12.1%)	6 (18.2%)	4 (12.1%)	6 (18.2%)	27 (25.2%)
Below Normal		>= 1,500,000	7 (21.2%)	6 (18.2%)	6 (18.2%)	6 (18.2%)	23 (21.5%)
Dry		>= 1,000,000	8 (24.2%)	7 (21.2%)	6 (18.2%)	5 (15.2%)	17 (15.9%)
Critical	Dry	>= 600,000	1 (3.0%)	3 (9.1%)	4 (12.1%)	5 (15.2%)	6 (5.6%)
Extreme Critical		< 600,000	2 (6.1%)	1 (3.0%)	1 (3.0%)	1 (3.0%)	2 (1.9%)

[1]The water year type classification is based on the predicted unimpaired inflow to Folsom Reservoir and spring forecasting information provided by the California Department of Water Resources Bulletin 120 report of water conditions published each month from February through May (DWR 2007). Snow surveys are usually done on or about the first of the month between February and May, weather permitting. The forecasts are published a week to ten days following the completion of the snow surveys. The May forecast determines the water year type until February of the following year.

Table 7.3-2b. Water Year Types[1] During the Period of Record (1975 to 2007).

Water Year within Relicensing Studies Period of Record (October 1, 1974 - September 30, 2007)	DWR Bulletin 120 Water Year Type[1]			
	March Forecast	April Forecast	May Forecast	End-of-Water-Year Forecast
	(Minimum Instream Flow)	(Pulse Flow)	(Minimum Instream Flow, Reservoir Minimum Pool, Recreation)	(Minimum Instream Flow)
1975	Below Normal	Above Normal	Above Normal	Above Normal
1976	Critical Dry	Critical	Critical	Critical
1977	Extreme Critical Dry	Extreme Critical	Extreme Critical	Extreme Critical
1978	Above Normal	Above Normal	Wet	Above Normal
1979	Below Normal	Below Normal	Below Normal	Below Normal
1980	Wet	Wet	Wet	Wet
1981	Dry	Dry	Dry	Dry
1982	Wet	Wet	Wet	Wet
1983	Wet	Wet	Wet	Wet
1984	Wet	Wet	Wet	Wet
1985	Below Normal	Below Normal	Below Normal	Below Normal
1986	Wet	Wet	Wet	Wet
1987	Dry	Dry	Critical	Critical
1988	Dry	Critical	Critical	Critical
1989	Dry	Below Normal	Below Normal	Below Normal
1990	Dry	Dry	Dry	Dry
1991	Extreme Critical Dry	Dry	Dry	Dry
1992	Dry	Dry	Dry	Critical
1993	Wet	Wet	Wet	Above Normal
1994	Dry	Critical	Critical	Critical
1995	Wet	Wet	Wet	Wet
1996	Above Normal	Above Normal	Wet	Wet
1997	Wet	Wet	Wet	Wet
1998	Wet	Wet	Wet	Wet
1999	Wet	Above Normal	Above Normal	Above Normal
2000	Above Normal	Above Normal	Above Normal	Above Normal
2001	Dry	Dry	Dry	Dry
2002	Below Normal	Below Normal	Below Normal	Below Normal
2003	Below Normal	Below Normal	Below Normal	Below Normal
2004	Below Normal	Below Normal	Below Normal	Below Normal
2005	Above Normal	Above Normal	Above Normal	Above Normal
2006	Wet	Wet	Wet	Wet
2007	Below Normal	Dry	Dry	Dry

[1]The water year type classification is based on the predicted unimpaired inflow to Folsom Reservoir and spring forecasting information provided by the California Department of Water Resources Bulletin 120 report of water conditions published each month from February through May (DWR 2007). Snow surveys are usually done on or about the first of the month between February and May, weather permitting. The forecasts are published a week to ten days following the completion of the snow surveys. The May forecast determines the water year type until February of the following year.

Table 7.3-3. Distances Between Points in Peaking Reach and Associated Water Travel Times.

Location	River Mile	Use	Distance from Oxbow PH to Location (Miles)	Elapsed Travel Time in Hours[1] (Distance/ 2.5 mph)
Middle Fork American River				
Indian Bar Rafter Access	24.35	Put-in	0	0
OXB gage	23.10	Gage	1.25	.5
Fords Bar (Crossing)	14.20	Trail crossing	10.15	4.1
Ruck-a-Chucky	9.22	Take-out/put-in/trail crossing	15.13	6.1
Poverty Bar (Crossing)	6.30	Trail crossing	18.05	7.2
Mammoth Bar	2.15	Take-out/put-in/trail crossing	22.20	8.9
Confluence	0	Take-out/put-in	24.35	9.7
North Fork American River				
Confluence	20.95	Take-out/put-in	24.35	9.7
Birdsall Access (Coffer Dam Crossing)	17.30	Take-out/put-in/trail crossing	28.00	11.2
Oregon Bar	15.65	Take-out	29.65	11.9

[1]Travel time assumes a base flow of 200 cfs and a peak flow of approximately 1,000 cfs. Travel time changes depending upon the base flow and the peak flow. For example, water travel time is faster when the base flow is higher or when the peak flow is higher.

Table 7.3-4. Flow Arrival Time in the Peaking Reach by Location.

Release Time	Indian Bar Rafter Access	OXB Gage	Fords Bar	Ruck-a-Chucky	Poverty Bar	Mammoth Bar	Confluence	Birdsall Access	Oregon Bar Access
12:00 AM	12:00 AM	12:30 AM	4:04 AM	6:03 AM	7:13 AM	8:53 AM	9:44 AM	11:12 AM	11:52 AM
2:00 AM	2:00 AM	2:30 AM	6:04 AM	8:03 AM	9:13 AM	10:53 AM	11:44 AM	1:12 PM	1:52 PM
4:00 AM	4:00 AM	4:30 AM	8:04 AM	10:03 AM	11:13 AM	12:53 PM	1:44 PM	3:12 PM	3:52 PM
6:00 AM	6:00 AM	6:30 AM	10:04 AM	12:03 PM	1:13 PM	2:53 PM	3:44 PM	5:12 PM	5:52 PM
8:00 AM	8:00 AM	8:30 AM	12:04 PM	2:03 PM	3:13 PM	4:53 PM	5:44 PM	7:12 PM	7:52 PM
10:00 AM	10:00 AM	10:30 AM	2:04 PM	4:03 PM	5:13 PM	6:53 PM	7:44 PM	9:12 PM	9:52 PM
11:00 AM	11:00 AM	11:30 AM	3:04 PM	5:03 PM	6:13 PM	7:53 PM	8:44 PM	10:12 PM	10:52 PM
12:00 PM	12:00 PM	2:04 PM	4:04 PM	6:03 PM	7:13 PM	8:53 PM	9:44 PM	11:12 PM	11:52 PM
2:00 PM	2:00 PM	2:30 PM	6:04 PM	8:03 PM	9:13 PM	10:53 PM	11:44 PM	1:12 AM	1:52 AM
4:00 PM	4:00 PM	4:30 PM	8:04 PM	10:03 PM	11:13 PM	12:53 AM	1:44 AM	3:12 AM	3:52 AM
6:00 PM	6:00 PM	6:30 PM	10:04 PM	12:03 AM	1:13 AM	2:53 AM	3:44 AM	5:12 AM	5:52 AM
8:00 PM	8:00 PM	8:30 PM	12:04 AM	2:03 AM	3:13 AM	4:53 AM	5:44 AM	7:12 AM	7:52 AM
10:00 PM	10:00 PM	10:30 PM	2:04 AM	4:03 AM	5:13 AM	6:53 AM	7:44 AM	9:12 AM	9:52 AM
12:00 AM	12:00 AM	12:30 AM	4:04 AM	6:03 AM	7:13 AM	8:53 AM	9:44 AM	11:12 AM	11:52 AM

Distance	0	1.25	10.15	15.13	18.05	22.20	24.35	28.00	29.65
Travel Time (hour:min)	0	0:30	4:04	6:03	7:13	8:53	9:44	11:12	11:52

Note: Travel time is 2.5 mph and assumes a base flow of 200 cfs and a peak flow of 1,000 cfs.
Travel time is faster when either base flow or peak flow increases.

Table 7.3-5. Hydrology Data Summary for Selected Locations in Waters Associated with the Middle Fork Project.

Site and Hydrology Node	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Small Bypass Streams													
Duncan Creek - Top of Reach (804.805)													
Impaired Hydrology	20%	2.2	7.5	14.0	16.0	16.0	18.0	17.0	20.0	12.0	6.3	1.9	1.3
	50%	1.0	2.6	7.2	11.0	12.0	14.0	13.0	11.0	8.7	2.6	1.0	0.8
	80%	0.6	1.3	3.4	4.6	6.0	11.0	9.3	8.4	4.4	1.2	0.5	0.5
	Average	2.1	8.2	19.7	24.9	25.2	20.0	16.4	29.3	14.6	4.2	1.4	1.1
	Max	196.0	674.0	1,730.0	2,560.0	2,020.0	1,070.0	651.0	834.0	252.0	105.0	9.2	12.0
	Min	0.1	0.3	0.7	0.8	0.9	3.0	4.1	3.4	1.2	0.1	0.1	0.1
Unimpaired Hydrology	20%	2.3	12.0	26.6	40.0	50.0	80.0	119.0	197.6	101.0	7.4	2.0	1.3
	50%	1.0	3.1	8.7	15.0	24.0	38.0	69.0	94.0	16.0	2.6	1.0	0.9
	80%	0.6	1.3	3.7	4.9	7.7	23.0	41.0	33.4	5.0	1.2	0.5	0.5
	Average	2.9	16.8	35.6	40.5	46.5	59.8	82.0	122.3	57.8	8.9	1.6	1.2
	Max	196.0	884.0	1,930.0	2,800.0	2,230.0	1,180.0	651.0	947.0	426.0	254.0	24.0	49.0
	Min	0.1	0.3	0.7	0.8	1.4	3.4	5.5	3.6	1.2	0.1	0.1	0.2
Duncan Creek - Bottom of Reach (805.806)													
Impaired Hydrology	20%	7.2	18.4	44.7	88.9	103.6	127.1	115.6	121.4	37.2	17.9	8.0	6.0
	50%	4.6	7.5	17.0	38.1	53.5	75.9	68.0	41.1	21.8	9.6	5.1	4.2
	80%	2.9	4.7	8.0	10.2	20.7	42.9	38.3	22.0	10.9	4.8	3.0	2.4
	Average	6.6	20.0	49.6	74.0	87.2	96.8	84.7	77.6	32.5	12.2	5.8	4.7
	Max	307.1	788.4	2,141.0	3,185.2	3,165.1	1,191.1	717.4	1,086.7	272.3	117.6	19.2	37.1
	Min	0.6	0.9	2.6	3.6	3.7	7.3	8.1	8.0	4.1	1.4	0.4	0.5
Unimpaired Hydrology	20%	7.5	22.3	59.5	116.5	132.5	188.2	210.4	277.9	121.8	20.0	8.2	6.0
	50%	4.7	7.9	19.3	41.4	68.4	100.9	128.2	140.1	29.7	9.6	5.1	4.2
	80%	2.9	4.7	8.1	10.2	21.5	56.6	79.9	47.8	11.8	4.9	3.0	2.4
	Average	7.4	28.7	65.5	89.6	108.5	136.6	150.4	170.7	75.8	16.9	6.0	4.8
	Max	347.1	998.4	2,341.0	3,185.2	3,375.1	1,301.1	717.4	1,285.7	501.6	266.6	34.4	74.1
	Min	0.6	0.9	2.6	3.7	3.7	7.7	10.8	8.0	4.1	1.4	0.4	0.6
North Fork Long Canyon Creek - Top of Reach (817.819)													
Impaired Hydrology	20%	0.5	2.2	5.9	8.5	8.7	10.5	5.6	5.5	3.9	1.4	0.5	0.4
	50%	0.3	0.8	2.4	3.1	3.5	3.5	3.1	3.2	2.1	0.7	0.3	0.3
	80%	0.2	0.4	1.0	1.4	2.0	2.6	2.0	2.0	0.9	0.4	0.2	0.1
	Average	0.5	3.1	8.8	10.6	10.7	9.1	8.7	8.0	3.1	1.1	0.4	0.3
	Max	29.9	184.1	765.5	692.3	572.3	242.8	216.8	212.7	30.8	13.4	2.0	5.2
	Min	0.0	0.1	0.0	0.3	0.3	0.7	0.6	0.9	0.2	0.1	0.0	0.0
Unimpaired Hydrology	20%	0.5	3.1	8.7	17.8	22.0	32.5	33.9	34.0	6.1	1.4	0.5	0.4
	50%	0.3	0.8	3.1	5.9	10.1	17.6	18.8	11.6	2.3	0.7	0.3	0.3
	80%	0.2	0.4	1.0	1.4	3.4	9.0	9.3	4.1	0.9	0.4	0.2	0.1
	Average	0.6	3.8	10.6	15.2	17.5	22.4	23.3	18.9	5.1	1.1	0.4	0.3
	Max	29.9	184.1	765.5	692.3	572.3	242.8	216.8	212.7	58.0	13.4	2.1	5.2
	Min	0.0	0.1	0.0	0.3	0.3	0.7	0.6	0.9	0.2	0.1	0.0	0.0

Table 7.3-5. Hydrology Data Summary for Selected Locations in Waters Associated with the Middle Fork Project.

Site and Hydrology Node	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Small Bypass Streams (continued)													
South Fork Long Canyon Creek - Top of Reach (820.822)													
Impaired Hydrology	20%	0.9	5.0	8.7	11.2	13.2	13.2	6.7	6.7	5.9	2.4	1.0	0.7
	50%	0.6	1.4	4.9	5.3	6.1	6.3	5.9	5.9	5.0	1.2	0.6	0.5
	80%	0.3	0.7	1.7	2.3	4.1	5.0	5.0	5.0	1.9	0.7	0.3	0.2
	Average	0.9	5.0	14.7	17.2	18.6	15.2	14.9	13.6	5.3	1.9	0.7	0.5
	Max	52.5	323.2	1,344.2	1,215.6	1,005.0	426.4	380.7	373.5	54.1	23.6	5.0	9.1
	Min	0.1	0.1	0.4	0.5	0.6	1.3	1.0	1.5	0.3	0.1	0.0	0.0
Unimpaired Hydrology	20%	0.9	5.4	14.6	30.5	40.0	55.5	60.9	61.0	19.0	2.4	1.0	0.7
	50%	0.6	1.4	5.3	10.4	19.0	31.2	35.8	29.2	5.4	1.2	0.6	0.5
	80%	0.3	0.7	1.7	2.3	6.3	15.0	18.6	10.8	1.9	0.7	0.3	0.2
	Average	0.9	7.2	18.2	26.4	31.6	39.3	43.6	38.7	12.2	2.2	0.7	0.5
	Max	52.5	323.2	1,344.2	1,215.6	1,005.0	426.4	380.7	373.5	121.0	24.3	6.0	9.1
	Min	0.1	0.1	0.4	0.5	0.6	1.3	1.0	1.5	0.3	0.1	0.0	0.0
Long Canyon Creek - Top of Reach (825.828)													
Impaired Hydrology	20%	2.3	11.9	31.5	59.3	64.0	78.0	70.0	61.1	15.0	6.3	2.5	1.8
	50%	1.5	3.5	12.4	20.0	23.0	30.0	29.0	19.6	9.3	3.2	1.6	1.2
	80%	0.8	1.8	4.4	6.1	10.0	16.0	14.5	11.0	4.5	1.8	0.8	0.6
	Average	2.3	14.0	44.3	59.9	61.9	60.9	57.3	45.9	13.5	4.6	1.7	1.3
	Max	138.0	849.0	3,531.0	3,193.2	2,640.0	1,120.0	1,000.0	981.1	142.0	62.0	6.9	24.0
	Min	0.2	0.5	1.1	1.2	1.6	3.3	2.7	3.6	0.8	0.3	0.1	0.1
Unimpaired Hydrology	20%	2.3	13.1	40.9	87.4	103.1	130.1	144.2	138.4	32.0	6.3	2.5	1.8
	50%	1.5	3.6	13.5	27.4	43.2	70.0	75.0	52.0	11.1	3.2	1.6	1.2
	80%	0.8	1.8	4.5	6.1	14.9	36.9	36.7	19.6	4.9	1.8	0.8	0.6
	Average	2.3	16.9	49.7	73.7	81.7	98.3	100.6	81.9	22.4	4.9	1.7	1.3
	Max	138.0	849.0	3,531.0	3,193.2	2,640.0	1,120.0	1,000.0	981.1	208.0	62.0	7.3	24.0
	Min	0.2	0.5	1.1	1.2	1.6	3.3	2.7	4.0	0.8	0.3	0.1	0.1
Long Canyon Creek - Bottom of Reach (830.842)													
Impaired Hydrology	20%	10.3	24.5	71.8	166.9	221.0	262.1	231.9	183.0	57.4	21.6	11.7	8.5
	50%	7.0	11.2	27.6	62.5	81.0	118.6	105.6	58.5	28.4	12.4	6.9	5.3
	80%	3.0	6.9	11.7	15.1	33.3	60.8	44.7	28.8	12.2	5.5	2.6	2.1
	Average	8.4	28.1	101.3	141.6	188.0	185.9	170.3	117.3	42.3	15.9	7.6	5.8
	Max	261.0	1,251.4	7,547.0	5,002.2	8,972.1	2,771.6	2,357.5	2,038.7	386.8	207.6	25.3	54.1
	Min	0.3	1.3	2.8	3.1	3.6	8.0	4.7	6.9	2.3	0.3	0.1	0.2
Unimpaired Hydrology	20%	10.3	27.5	79.5	193.2	256.1	315.6	315.3	258.1	70.2	22.4	11.7	8.5
	50%	7.0	11.2	29.1	68.0	103.0	159.5	152.6	89.4	32.0	12.4	6.9	5.3
	80%	3.0	6.9	11.9	15.1	36.5	77.1	66.0	35.3	12.3	5.5	2.6	2.1
	Average	8.5	31.0	106.6	155.3	207.8	223.3	213.6	153.2	51.2	16.2	7.6	5.8
	Max	261.0	1,251.4	7,547.0	5,002.2	8,972.1	2,771.6	2,357.5	2,038.7	386.8	207.6	26.3	54.1
	Min	0.3	1.3	2.8	3.1	3.6	8.0	4.7	8.8	2.3	0.3	0.1	0.2

Table 7.3-5. Hydrology Data Summary for Selected Locations in Waters Associated with the Middle Fork Project.

Site and Hydrology Node	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Large Bypass Rivers													
Rubicon River - Below Hell Hole Reservoir (540.832)													
Impaired Hydrology	20%	30.6	23.0	22.0	17.0	20.0	21.0	21.0	25.0	25.0	23.0	23.0	23.0
	50%	22.0	22.0	15.0	13.0	14.0	15.0	15.0	21.0	22.0	22.0	22.0	22.0
	80%	10.0	14.0	12.0	12.0	12.0	12.0	13.0	14.0	20.0	18.0	11.0	11.0
	Average	23.8	19.6	25.9	65.0	20.9	30.5	20.7	105.0	107.4	43.3	18.6	21.1
	Max	69.0	55.0	4,350.0	17,100.0	1,190.0	6,650.0	557.0	8,720.0	1,950.0	1,350.0	31.0	66.0
	Min	4.3	6.5	5.6	5.9	6.1	5.9	7.7	7.7	0.3	6.5	6.5	5.9
Unimpaired Hydrology	20%	44.2	148.7	231.2	337.0	404.3	668.2	1,094.5	1,866.9	1,495.2	347.1	41.4	23.7
	50%	15.0	44.7	90.4	137.4	204.4	345.1	656.1	1,083.7	471.2	66.7	15.9	13.8
	80%	7.9	17.5	31.5	50.8	86.0	214.9	414.3	528.4	124.0	20.1	9.8	7.2
	Average	52.4	178.8	310.7	337.6	364.4	514.9	771.8	1,263.3	812.5	220.4	38.1	28.4
	Max	3,325.8	6,698.9	14,247.7	26,764.3	13,184.2	8,758.8	5,834.2	9,341.8	3,861.0	2,956.5	545.7	1,791.3
	Min	0.0	2.2	2.4	1.3	12.3	24.0	95.1	79.6	26.0	2.1	1.9	0.8
Rubicon River - Below South Fork Rubicon River (834.836)													
Impaired Hydrology	20%	52.0	45.0	71.5	147.2	187.8	225.4	203.5	186.9	85.7	55.4	47.2	47.2
	50%	43.7	38.5	41.0	57.5	83.9	120.8	107.0	73.8	58.3	43.2	37.7	39.0
	80%	28.6	31.8	30.7	31.0	42.0	68.1	55.9	46.2	39.1	33.1	28.7	26.9
	Average	43.5	57.7	118.3	206.6	181.8	185.9	150.7	208.8	159.0	68.1	37.1	38.8
	Max	570.8	3,354.5	9,413.1	27,559.9	11,308.5	10,627.9	2,662.3	12,194.1	2,349.8	1,512.7	63.2	188.2
	Min	9.2	10.8	13.0	15.4	15.1	15.2	13.3	14.8	12.2	8.8	8.3	8.3
Unimpaired Hydrology	20%	65.4	170.1	290.1	463.4	556.1	874.8	1,241.9	1,994.4	1,557.8	380.0	64.9	45.3
	50%	33.9	60.8	119.2	189.3	287.7	468.5	765.9	1,168.2	515.7	88.4	35.5	31.2
	80%	22.8	33.1	49.9	69.5	115.5	283.5	509.4	571.0	144.8	33.3	21.3	18.9
	Average	72.1	216.9	403.1	479.1	525.2	670.3	901.8	1,367.1	864.1	245.2	56.6	46.0
	Max	3,514.1	9,002.0	23,573.8	38,770.1	24,356.6	12,736.7	8,438.4	12,815.9	4,538.7	3,229.2	582.8	1,954.6
	Min	4.0	6.2	14.6	11.2	23.2	34.9	103.6	100.7	36.0	4.6	3.7	5.1
Rubicon River - Above Ralston Afterbay (842.815+815ACC)													
Impaired Hydrology	20%	78.0	93.2	220.1	567.4	777.1	934.1	822.2	716.4	234.1	111.3	78.3	72.2
	50%	65.5	67.1	97.4	193.6	290.0	447.0	392.5	195.0	122.5	75.0	56.0	54.3
	80%	42.0	49.7	58.9	64.9	115.0	204.8	160.0	104.1	65.0	47.0	39.2	37.0
	Average	65.6	115.3	345.3	543.6	669.8	666.0	588.3	489.1	260.5	107.5	58.2	55.6
	Max	1,060.0	5,400.1	26,427.4	40,451.5	35,600.2	14,812.7	8,270.5	13,459.0	3,230.1	1,790.1	131.2	289.0
	Min	11.0	14.0	20.0	25.0	23.0	31.0	22.0	28.3	17.0	9.9	8.9	9.0
Unimpaired Hydrology	20%	96.5	229.8	483.5	916.5	1,134.9	1,507.7	1,817.0	2,462.2	1,707.6	436.8	99.4	70.0
	50%	56.9	95.0	186.1	338.9	520.2	835.4	1,153.3	1,479.6	601.0	125.7	58.4	48.7
	80%	34.3	56.6	84.3	103.2	209.1	463.2	716.5	637.7	177.2	49.4	30.2	25.7
	Average	96.8	284.1	633.1	818.4	1,004.5	1,167.7	1,359.7	1,680.6	979.7	288.5	79.3	64.3
	Max	4,077.3	11,419.6	39,588.2	48,696.2	47,138.4	16,855.5	13,594.6	15,713.8	5,068.0	3,432.5	653.8	2,089.9
	Min	5.1	10.7	23.6	24.6	34.4	61.1	125.0	133.9	43.3	5.3	4.1	5.6

Table 7.3-5. Hydrology Data Summary for Selected Locations in Waters Associated with the Middle Fork Project.

Site and Hydrology Node	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Large Bypass Rivers (continued)													
Middle Fork American River - Below French Meadows Reservoir (530.802)													
Impaired Hydrology	20%	9.9	10.0	11.0	13.0	14.0	15.6	14.0	17.0	12.0	10.0	10.0	9.9
	50%	9.1	9.5	9.8	10.0	10.0	12.0	11.0	9.9	9.7	9.5	9.2	9.3
	80%	7.7	7.7	8.2	8.7	8.6	9.5	9.3	8.5	7.7	7.6	7.7	7.7
	Average	9.1	9.4	11.2	20.2	19.5	23.8	17.7	61.6	36.3	15.1	8.6	9.8
	Max	75.0	71.0	164.0	3,280.0	993.0	2,380.0	531.0	3,430.0	690.0	521.0	11.0	152.0
	Min	2.7	2.8	2.8	4.1	4.4	4.1	3.9	2.7	3.1	2.8	2.7	2.6
Unimpaired Hydrology	20%	8.1	50.1	95.5	169.9	213.2	345.6	529.3	791.2	451.3	65.1	9.0	5.9
	50%	4.4	13.1	31.4	53.1	110.6	185.7	315.4	424.6	127.9	12.0	4.7	4.0
	80%	2.4	5.2	13.3	21.4	35.9	107.1	191.7	176.8	35.3	5.4	2.7	2.0
	Average	11.8	69.7	133.2	163.3	194.1	268.8	370.5	507.8	258.2	53.0	8.5	5.3
	Max	932.5	3,259.9	6,465.8	10,433.5	8,355.0	4,830.9	2,631.6	4,064.7	1,558.6	994.3	120.4	233.3
	Min	0.3	1.3	1.8	3.7	5.0	15.7	28.1	25.0	8.3	1.1	0.5	0.4
Middle Fork American River - Above Middle Fork Interbay (806.810+810ACC)													
Impaired Hydrology	20%	25.5	45.6	108.8	222.8	260.5	331.2	297.4	342.4	101.7	47.4	27.5	23.0
	50%	19.6	24.1	41.7	91.1	133.5	190.5	172.0	104.0	52.0	29.7	20.7	19.3
	80%	15.1	18.6	24.3	28.2	51.6	105.9	93.3	53.7	30.4	19.2	14.9	13.6
	Average	23.1	49.2	110.3	175.3	208.9	246.7	215.5	216.8	98.3	40.2	21.7	20.1
	Max	604.6	1,071.1	2,985.4	7,801.0	5,238.7	3,231.7	1,169.0	3,604.5	953.9	575.7	53.8	117.7
	Min	7.6	8.6	13.1	10.0	15.5	18.8	18.5	18.7	12.3	7.5	6.1	5.8
Unimpaired Hydrology	20%	22.0	85.0	193.1	388.3	455.9	661.0	854.9	1,146.8	611.0	99.5	25.5	17.6
	50%	13.6	27.9	67.2	124.8	232.6	368.7	524.6	629.8	173.0	29.7	14.9	12.4
	80%	8.8	14.0	27.3	39.8	76.6	213.9	326.6	244.5	55.8	15.6	9.5	7.1
	Average	24.7	113.0	235.4	313.2	378.8	499.7	604.8	737.9	356.1	79.8	19.9	14.6
	Max	1,398.1	4,288.4	9,311.8	13,793.5	13,137.0	6,280.9	3,430.6	5,799.7	2,105.3	1,276.3	167.6	338.3
	Min	2.7	4.2	11.1	10.0	11.5	30.3	45.5	38.5	16.4	4.8	2.5	2.7
Middle Fork American River - Below Middle Fork Interbay (810.812)													
Impaired Hydrology	20%	24.0	24.0	25.0	26.8	34.9	124.7	136.4	94.8	64.1	24.0	24.0	24.0
	50%	20.0	23.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	23.0	20.0
	80%	15.0	18.0	19.0	19.0	23.0	23.0	23.0	23.0	21.0	20.0	15.0	15.0
	Average	20.4	24.5	62.5	92.8	127.8	118.0	98.0	124.8	76.1	30.7	20.4	20.1
	Max	180.2	601.6	2,885.9	7,616.1	4,993.0	3,261.7	1,373.1	3,931.4	881.1	615.2	48.0	119.0
	Min	4.8	6.3	8.5	6.9	11.0	11.0	11.0	7.6	7.8	5.7	5.5	5.5
Unimpaired Hydrology	20%	29.6	106.1	252.5	502.3	585.6	844.9	1,065.0	1,427.5	732.4	120.0	33.9	23.7
	50%	18.3	35.9	86.5	168.3	301.5	470.5	650.7	766.8	204.0	39.4	20.1	16.6
	80%	11.8	18.9	35.5	51.1	98.9	273.0	406.2	293.0	68.2	20.5	12.5	9.7
	Average	32.1	141.7	300.9	402.9	487.3	636.3	755.2	908.5	431.8	96.7	25.9	19.4
	Max	1,745.2	5,286.8	11,652.8	16,844.7	16,512.0	7,582.0	4,148.0	7,085.4	2,606.9	1,542.8	202.0	412.4
	Min	3.4	5.0	13.7	13.7	15.2	38.0	56.4	46.5	20.5	6.2	2.9	3.3

Table 7.3-5. Hydrology Data Summary for Selected Locations in Waters Associated with the Middle Fork Project.

Site and Hydrology Node	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Large Bypass Rivers (continued)													
Middle Fork American River - Above Ralston Afterbay (813.845)													
Impaired Hydrology	20%	51.1	61.8	88.4	142.9	203.0	281.5	237.2	177.3	104.8	47.1	38.6	35.5
	50%	35.3	38.1	45.3	51.7	89.8	106.3	87.8	74.2	47.0	37.0	31.3	29.5
	80%	22.7	28.4	36.3	36.7	42.4	68.1	42.3	43.7	33.9	27.0	19.9	18.9
	Average	40.1	59.3	131.2	171.5	242.2	218.1	190.6	185.1	104.8	46.1	30.5	29.2
	Max	375.8	1,764.6	6,253.2	10,952.8	10,409.8	3,521.2	2,656.6	4,144.6	924.9	644.4	72.5	131.5
	Min	8.7	8.7	12.1	13.2	17.7	22.7	12.5	14.5	13.0	6.7	6.2	6.4
Unimpaired Hydrology	20%	55.1	135.3	318.0	609.7	704.2	987.8	1,191.2	1,520.7	776.3	143.4	48.8	36.1
	50%	32.5	55.0	111.1	197.0	359.8	550.0	713.4	826.0	231.1	53.7	29.0	25.9
	80%	19.7	30.1	55.8	71.0	132.7	318.5	443.9	315.2	81.8	28.0	17.4	14.2
	Average	51.7	176.5	369.5	481.6	601.7	736.4	847.8	968.9	460.5	112.1	35.9	28.5
	Max	1,940.8	6,449.9	15,020.0	20,378.9	21,928.8	7,841.5	5,665.6	8,054.1	2,715.3	1,577.6	219.5	499.3
	Min	9.7	11.4	15.9	20.8	25.8	56.6	66.2	49.7	27.8	7.9	5.1	5.7
Middle Fork American River Peaking Reach													
Middle Fork American River - Below Ralston Afterbay (855.857)													
Impaired Hydrology	20%	742.0	843.2	1,220.0	1,966.0	2,378.0	2,780.0	2,282.0	2,160.0	1,390.0	1,000.0	983.6	830.2
	50%	187.0	572.0	613.0	777.0	1,200.0	1,560.0	1,350.0	1,190.0	798.0	741.0	746.0	600.0
	80%	94.0	187.8	209.0	287.0	450.4	635.4	466.6	324.0	430.6	480.8	487.8	244.4
	Average	389.4	676.9	1,137.9	1,532.3	1,852.7	1,900.6	1,620.7	1,481.1	1,021.3	758.0	711.6	572.2
	Max	2,910.0	15,500.0	35,700.0	64,500.0	46,400.0	23,200.0	19,500.0	23,500.0	4,430.0	3,640.0	1,230.0	1,260.0
	Min	41.0	51.0	54.0	75.0	79.0	79.0	69.0	76.0	50.0	64.0	65.0	65.0
Unimpaired Hydrology	20%	192.3	459.6	1,054.0	2,142.3	2,601.3	3,312.7	3,749.2	4,524.7	2,716.1	646.7	189.8	138.2
	50%	119.6	199.7	375.8	736.5	1,190.9	1,921.1	2,316.3	2,648.1	929.4	229.0	117.7	103.8
	80%	76.0	119.1	190.8	236.6	464.9	1,061.1	1,435.6	1,067.9	312.1	106.0	66.9	60.9
	Average	186.1	584.1	1,321.2	1,787.5	2,178.5	2,525.1	2,729.4	3,028.2	1,571.7	453.4	147.9	121.8
	Max	7,238.7	24,400.7	69,512.9	86,289.3	86,138.3	32,132.0	25,025.0	27,405.0	8,209.0	5,252.3	964.0	2,804.2
	Min	24.7	34.8	60.6	69.6	76.1	161.4	234.2	200.9	101.2	23.0	18.8	19.1
Middle Fork American River - Above Otter Creek (860.863)													
Impaired Hydrology	20%	749.5	850.7	1,231.5	1,996.9	2,406.1	2,823.7	2,326.6	2,202.5	1,418.6	1,015.5	990.4	837.6
	50%	194.0	581.0	622.5	790.6	1,215.1	1,589.7	1,380.3	1,218.5	811.7	747.4	752.9	605.6
	80%	100.2	196.0	217.5	295.2	460.9	653.3	490.3	342.8	439.6	486.5	493.5	249.6
	Average	396.4	688.5	1,158.1	1,557.5	1,882.8	1,933.6	1,655.2	1,518.8	1,043.0	767.8	718.1	578.4
	Max	2,996.6	15,794.0	36,242.7	65,335.7	47,434.6	23,560.3	19,822.3	23,741.4	4,503.3	3,697.9	1,245.0	1,270.5
	Min	46.9	56.1	59.6	81.5	84.7	85.9	77.4	84.3	59.7	69.3	70.4	70.6
Unimpaired Hydrology	20%	199.4	471.1	1,070.7	2,169.8	2,641.1	3,352.9	3,794.9	4,577.8	2,749.7	658.6	196.8	144.6
	50%	125.8	206.7	384.7	749.2	1,210.1	1,946.3	2,346.4	2,680.4	944.0	236.4	123.8	109.9
	80%	81.5	125.3	198.5	244.6	475.3	1,077.7	1,455.6	1,083.6	320.1	111.7	72.5	66.1
	Average	193.1	595.7	1,341.4	1,812.7	2,208.6	2,558.1	2,763.9	3,065.9	1,593.4	463.2	154.4	128.0
	Max	7,325.3	24,694.7	70,316.3	87,310.3	87,172.9	32,492.3	25,347.3	27,720.6	8,303.4	5,314.2	979.6	2,841.7
	Min	29.7	39.8	65.9	75.0	81.8	168.1	241.6	207.8	107.0	27.8	23.6	23.9

Table 7.3-5. Hydrology Data Summary for Selected Locations in Waters Associated with the Middle Fork Project.

Site and Hydrology Node	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Middle Fork American River Peaking Reach (continued)													
Middle Fork American River - Above North Fork American Confluence (866.868)													
Impaired Hydrology	20%	758.8	862.5	1,247.1	2,030.0	2,446.8	2,879.7	2,375.7	2,256.6	1,464.4	1,033.2	999.8	847.5
	50%	202.8	593.3	636.4	811.7	1,239.2	1,627.3	1,430.9	1,273.1	836.3	758.8	761.8	614.5
	80%	108.9	208.9	228.8	307.8	475.3	675.1	524.7	370.1	452.2	495.0	502.6	257.5
	Average	406.4	704.9	1,186.3	1,592.9	1,924.4	1,980.1	1,704.4	1,574.0	1,075.1	782.2	727.7	587.5
	Max	3,121.3	16,198.7	37,036.2	66,484.9	48,809.5	24,099.4	20,257.0	24,101.3	4,613.1	3,785.0	1,267.3	1,285.4
	Min	55.5	63.7	67.8	89.8	93.2	95.6	90.1	96.7	74.1	77.2	78.4	78.8
Unimpaired Hydrology	20%	209.0	485.6	1,094.8	2,209.2	2,690.9	3,407.8	3,854.0	4,654.9	2,799.0	675.8	206.7	153.9
	50%	134.7	217.0	397.2	768.0	1,236.5	1,983.3	2,389.9	2,731.0	965.2	247.1	132.9	118.6
	80%	89.7	134.5	208.9	255.4	489.9	1,102.3	1,485.0	1,106.7	331.8	120.1	80.8	73.9
	Average	203.1	612.1	1,369.6	1,848.1	2,250.2	2,604.6	2,813.1	3,121.1	1,625.5	477.6	163.9	137.1
	Max	7,450.0	25,099.4	71,415.0	88,734.4	88,547.8	33,031.4	25,782.0	28,165.2	8,444.5	5,407.1	1,002.7	2,895.6
	Min	37.1	47.4	73.8	83.1	90.0	177.8	252.4	218.1	115.6	35.2	30.9	31.3

Powerhouse	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Project Powerhouses[1]													
French Meadows Powerhouse (530.540)	20%	329.7	299.4	243.8	245.3	328.3	342.3	326.4	328.9	326.4	321.5	322.3	318.1
	50%	220.9	25.3	0.0	0.0	83.7	111.9	0.0	0.0	197.2	229.2	234.7	209.0
	80%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	149.8	174.0	0.0
	Average	190.5	128.1	98.0	92.4	139.7	152.9	123.4	126.4	179.9	222.2	229.8	195.2
	Max	404.3	390.4	377.0	397.7	394.3	398.4	400.8	391.2	389.3	388.3	363.2	364.9
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Middle Fork Powerhouse (823.810)	20%	573.4	586.4	671.0	516.5	779.3	825.0	830.4	897.6	892.8	811.6	827.6	675.9
	50%	52.7	391.4	265.9	221.8	335.5	340.0	260.6	406.2	553.3	563.7	609.5	451.6
	80%	0.0	26.4	6.0	0.0	8.8	0.0	0.0	0.0	232.7	344.3	380.0	125.2
	Average	259.0	358.1	343.2	289.3	389.9	409.3	378.6	446.7	540.9	547.1	577.2	439.8
	Max	989.8	933.0	978.4	964.6	963.4	985.7	954.7	982.5	980.8	949.8	947.8	952.8
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ralston Powerhouse (810.815)	20%	590.9	602.3	738.8	642.6	889.7	908.2	909.8	910.4	909.0	816.8	817.8	673.4
	50%	55.3	437.0	322.9	284.5	441.2	572.2	451.1	577.5	582.8	590.8	607.0	479.6
	80%	0.0	44.2	24.5	23.7	40.8	71.9	61.3	47.7	254.1	372.9	408.1	129.6
	Average	267.1	389.5	382.9	356.1	447.0	501.3	464.0	517.8	561.7	560.2	582.7	448.2
	Max	971.0	917.3	931.0	924.7	930.2	929.9	929.7	930.1	930.2	1,118.3	929.9	925.0
	Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 7.3-5. Hydrology Data Summary for Selected Locations in Waters Associated with the Middle Fork Project.

Powerhouse	Exceedances and Summary Statistics	Flow (cfs) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Project Powerhouses (continued)													
Oxbow Powerhouse (845.847)	20%	0.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	963.3	792.7
	50%	0.0	899.8	635.9	430.8	738.4	1,000.0	1,000.0	1,000.0	750.2	764.1	728.2	424.1
	80%	0.0	282.1	202.7	146.0	196.1	355.0	295.7	202.9	362.3	458.8	435.3	278.1
	Average	80.8	706.1	615.6	542.0	632.9	727.3	720.4	663.4	708.7	730.6	696.3	509.2
	Max	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0
	Min	0.0	0.0	75.0	75.0	75.0	80.0	75.0	78.1	75.0	121.0	112.8	94.9

Reservoir	Exceedances and Summary Statistics	Storage (AF) 1975 - 2007											
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Project Reservoirs													
French Meadow Reservoir (530)	20%	86,165.2	73,505.6	71,860.0	79,740.8	92,408.0	95,001.8	101,457.6	124,000.0	133,600.0	130,488.4	114,885.2	100,061.4
	50%	75,255.0	62,585.0	57,400.0	59,300.0	61,100.0	67,200.0	83,500.0	103,800.0	124,050.0	119,335.0	105,361.0	89,750.0
	80%	46,140.0	42,579.0	43,293.0	48,888.0	49,572.0	50,404.0	62,559.2	85,060.0	97,651.0	90,940.0	71,940.0	58,420.0
	Average	69,993.6	61,132.1	59,661.6	64,444.6	66,636.4	70,688.7	81,193.9	101,735.7	115,689.5	110,282.0	95,845.9	81,621.1
	Max	100,035.0	99,404.0	112,870.0	122,900.0	116,180.0	121,200.0	127,900.0	136,100.0	137,113.0	136,405.0	131,441.0	112,248.0
	Min	28,500.0	29,200.0	29,800.0	30,400.0	30,900.0	34,000.0	40,323.0	46,520.0	53,654.0	51,784.0	33,900.0	33,100.0
Hell Hole Reservoir (540)	20%	138,476.4	135,232.2	129,125.2	128,076.8	140,056.8	165,629.0	172,161.6	198,400.0	205,072.0	196,961.2	173,054.6	148,231.4
	50%	123,100.0	114,100.0	105,700.0	101,787.0	102,050.0	107,512.0	123,050.0	155,300.0	187,151.0	176,057.0	146,100.0	124,520.0
	80%	101,600.0	85,500.0	77,733.6	77,400.0	78,620.0	81,081.8	99,093.4	124,165.8	144,781.6	136,023.2	125,028.0	102,980.0
	Average	117,588.8	110,612.1	105,430.6	108,953.8	110,845.3	117,324.7	132,576.4	158,490.3	174,011.7	164,780.4	144,001.1	123,256.1
	Max	167,400.0	182,702.0	211,050.0	213,100.0	208,845.0	210,700.0	208,845.0	211,100.0	209,348.0	209,000.0	202,018.0	181,825.0
	Min	35,000.0	34,001.0	40,100.0	40,200.0	41,700.0	51,100.0	71,900.0	87,836.0	83,000.0	74,400.0	50,600.0	37,509.0

[1]No data are available for Hell Hole Powerhouse.

Table 7.3-6. Summary of General Characteristics of the Middle Fork Project Reservoirs.

Water Storage Reservoirs[1]	Gross Storage (AF)	Minimum Surface Area[2] (acres)	Maximum Surface Area[3] (acres)	Maximum Operating Water Surface Elevation (ft)	Minimum Operating Water Surface Elevation (ft)	Minimum Depth[2] (ft)	Maximum Depth[3] (ft)	Mean Depth (Gross Storage/ Max Surface Area)[4] (ft)	Substrate Composition	Flushing Rate (days)	Maximum Shoreline Length (miles)
French Meadows Reservoir	134,993	434	1,408	5,262	5,125	77	214	96 (170)	Predominately thin veneer of fine to coarse sand. Low-flow channel area of the former Middle Fork American River channel is predominately boulder, cobble, and bedrock. Smaller pocket of gravel and gravel mixed with sand near the delta inlet of the reservoir downstream from the bridge crossing over the Middle Fork American River at the upper end of the reservoir.	495	9
Hell Hole Reservoir	207,590	185	1,253	4,630	4,340	88	378	156 (307)	Predominately fine to coarse sand with numerous smaller sections of exposed bedrock. Smaller areas of cobble and cobble mixed with boulders and bedrock on former banks of the Rubicon River. Some gravel pockets, and gravel mixed with sand, mostly confined to sections of the former low-flow channel width of the Rubicon River.	330	11
Middle Fork Interbay	175	3	7	2,529	2,502	37	64	25 (See footnote[5])	Predominately coarser material near the delta inlet (cobble, boulder, bedrock) grading to finer sands and silts approaching the dam.	<1	1
Ralston Afterbay	2,782	40[6]	83	1,178	1,167	62	130	34 (See footnote[5])	Predominately coarser material near the delta inlet at the convergence of the Rubicon River and Middle Fork American River, grading to finer sands and silts approaching the dam. Near surface particle sizes of four bars near the delta inlet ranged from very fine sand to small cobbles, commonly with gravels mixed with sands. The average particle size of the bars is coarse gravel sized materials.	2-3	4

[1]The small diversion facilities were not included as storage reservoirs. These are Duncan Creek, North Fork Long Canyon Creek, and South Fork Long Canyon Creek diversion pools.

[2]Corresponds to the minimum operating water surface elevation.

[3]Corresponds to the maximum operating water surface elevation.

[4]The first number is the gross storage divided by the maximum surface area. The number in parenthesis is the temporal mean depth and corresponds to the average reservoir storage from 1974 to 2004 at the following stations: French Meadows Reservoir (No. 11427400) and Hell Hole Reservoir (No. 11428700)

[5]Data were not available to calculate the temporal mean depth. These reservoirs are afterbays and forebays for powerhouses. Middle Fork Interbay typically is held near full pool and Ralston Afterbay typically operates within 10 feet of full pool.

[6]Very coarse estimate of the minimum surface area based on USGS quadrangle maps.

FIGURES

Figure 7.3-1. Mean Annual Runoff into Folsom Reservoir from the American River Basin.

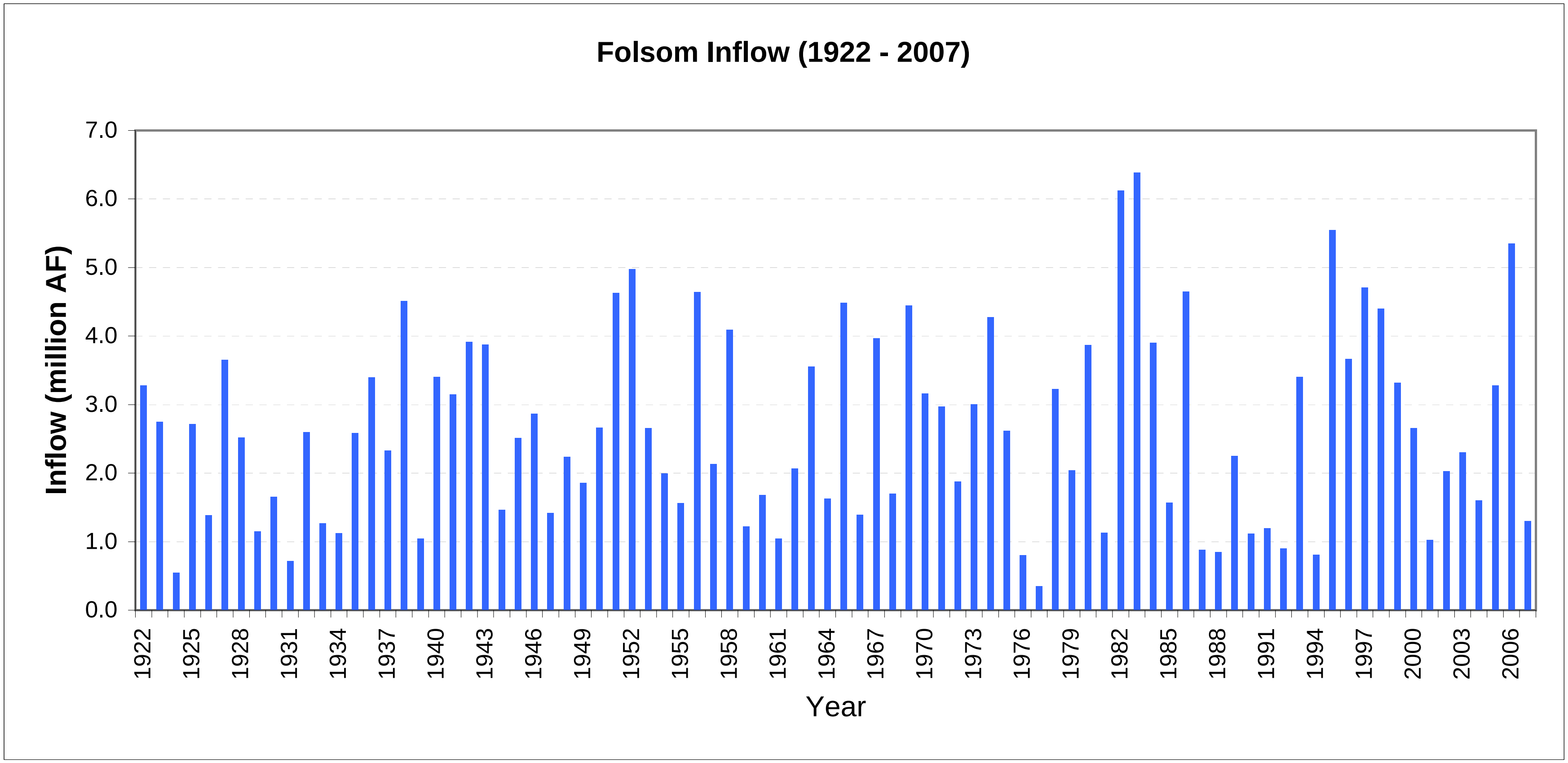
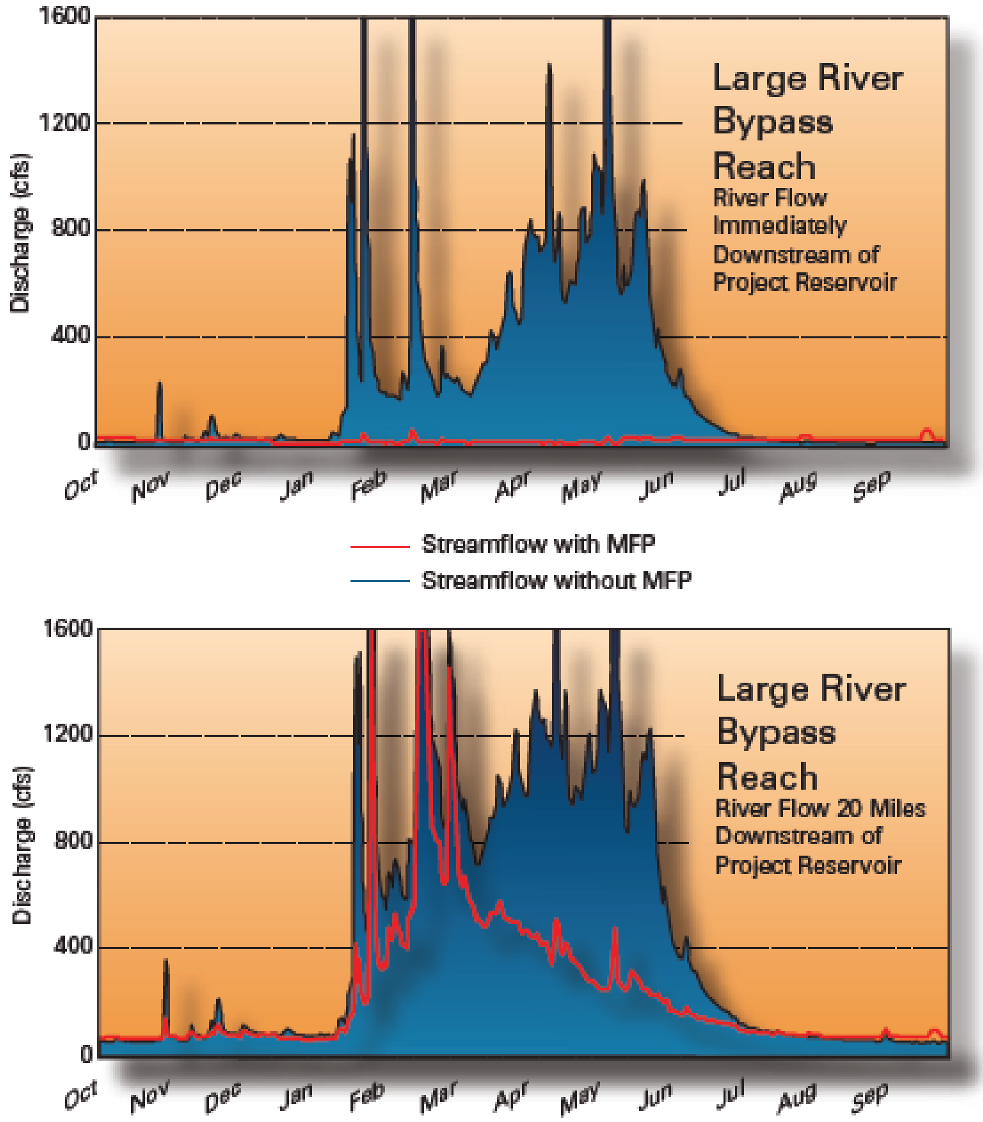
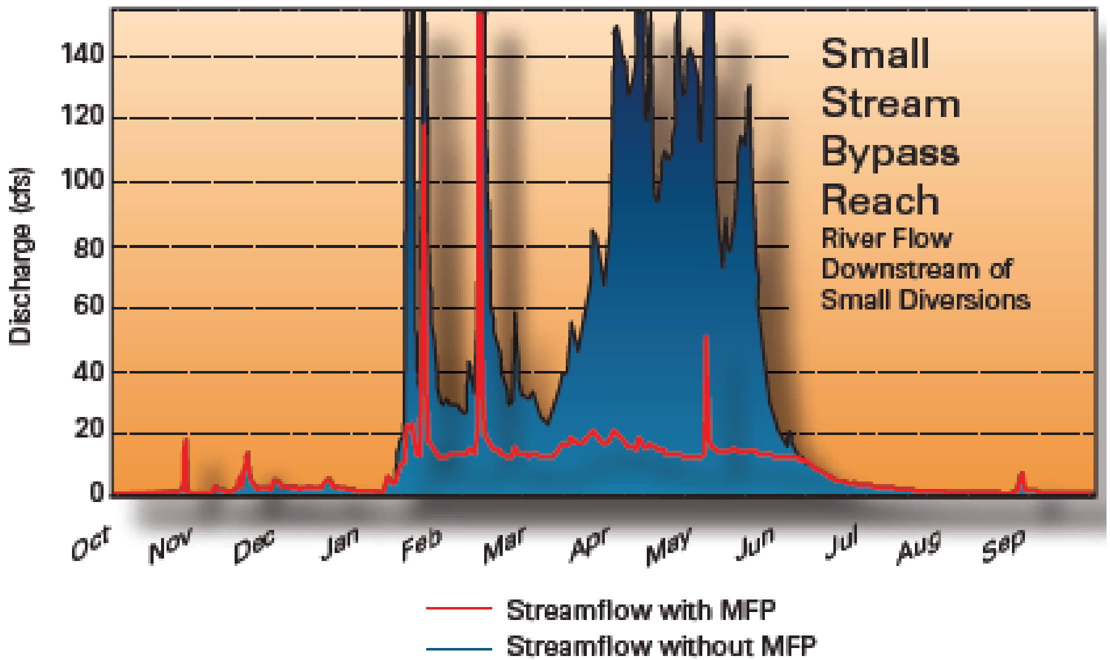


Figure 7.3-2. Example of Project Modification of Flows in the Large River Bypass Reaches of the Middle Fork American and Rubicon Rivers.



Note: Accretion flows in the lower portions (bottom) of the reaches restore some of the natural winter and spring high flow variability to the hydrograph compared to the upper portions of the reaches (top).

Figure 7.3-3. Example of Project Modification of Flows in the Small Stream Bypass Reaches (Duncan Creek and North and South Fork Long Canyon Creeks).



Note: Flows are reduced during the late winter and spring. However, the diversions are shut off during the summer, fall and early winter and flows in the bypass reaches during these periods are unaltered.

Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project.

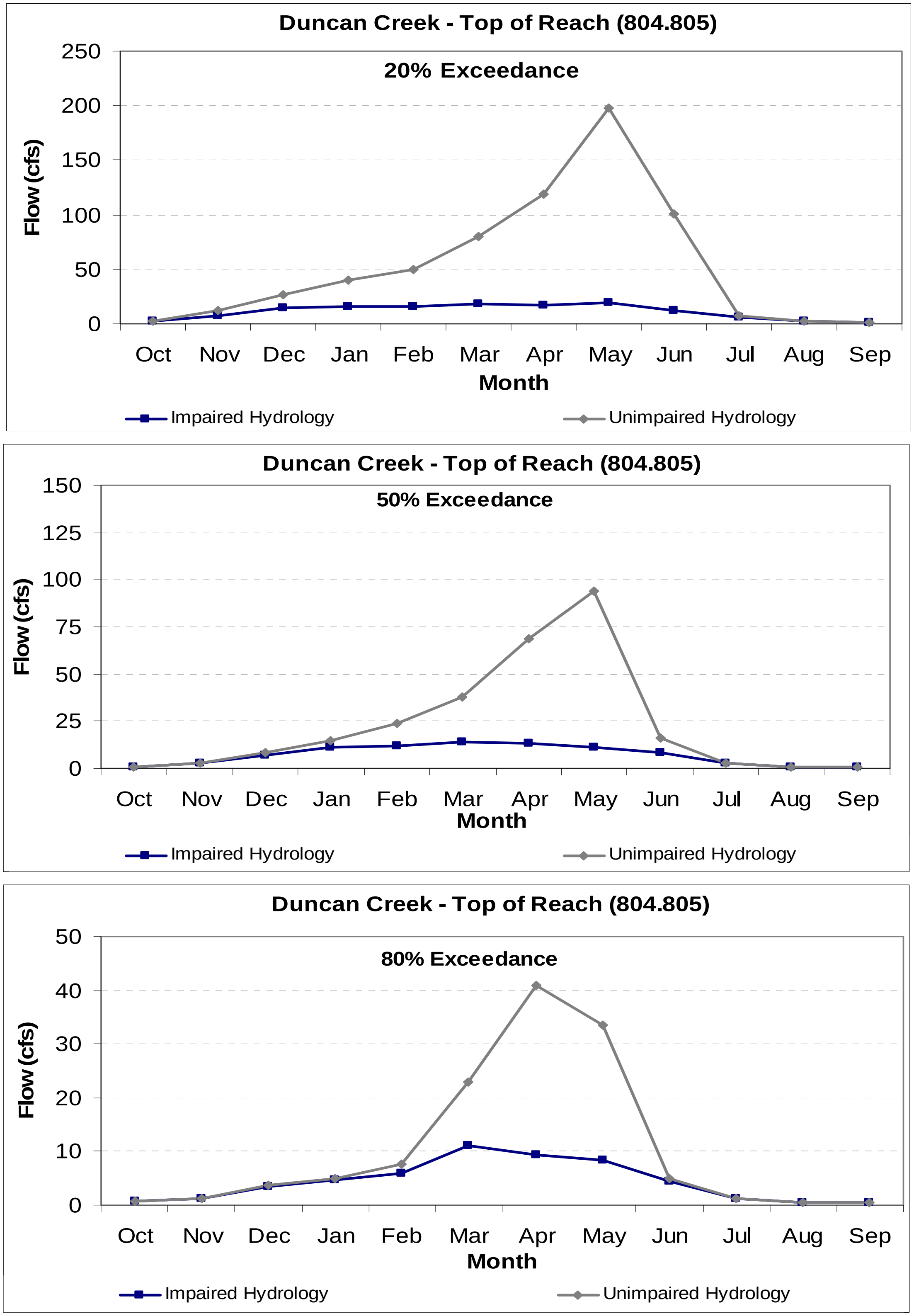
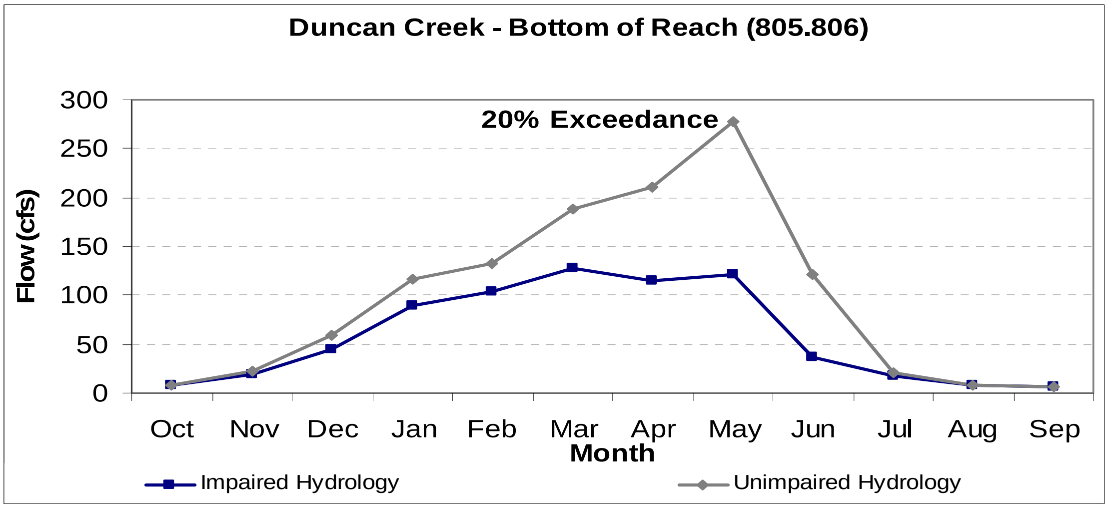
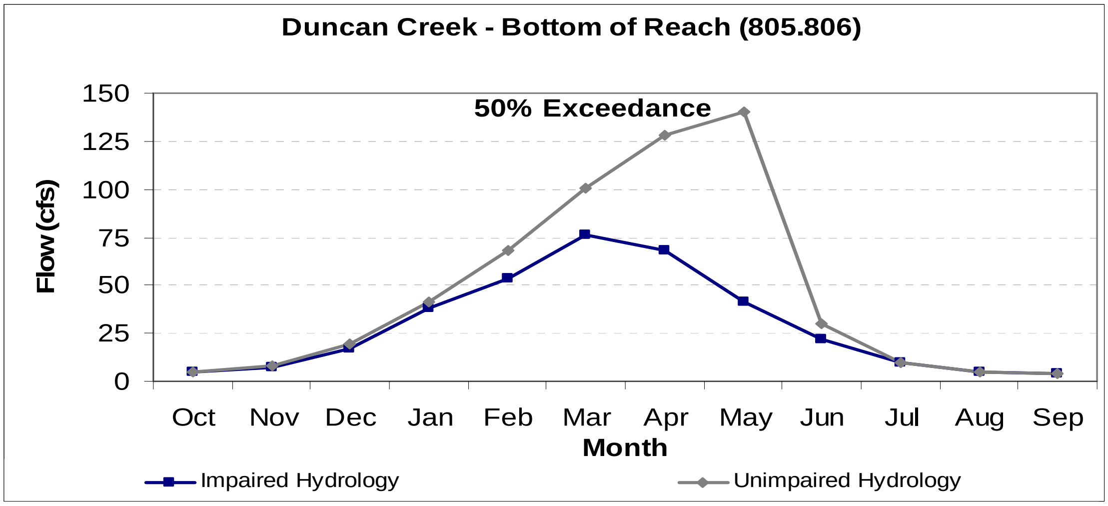


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).

Small Bypass Streams





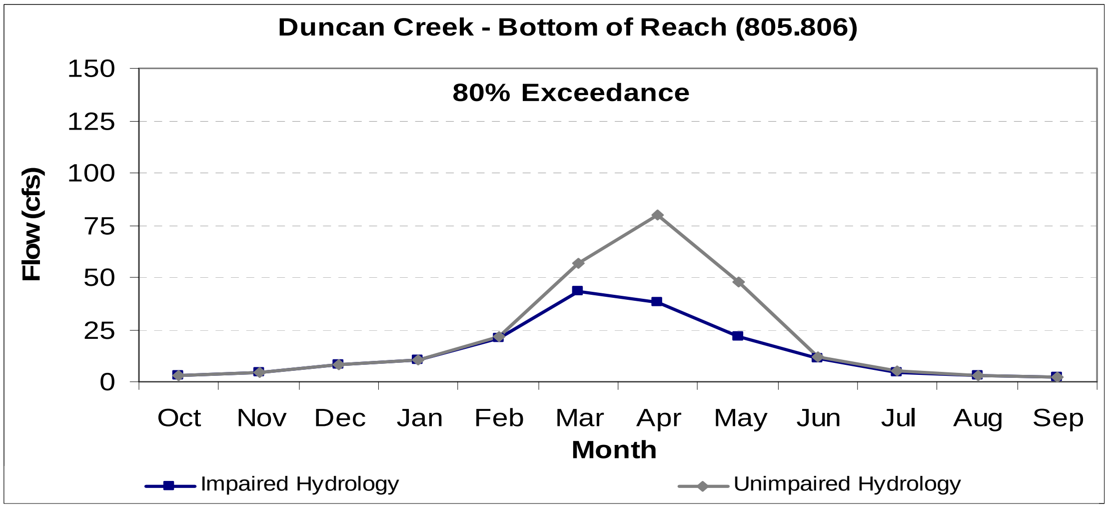
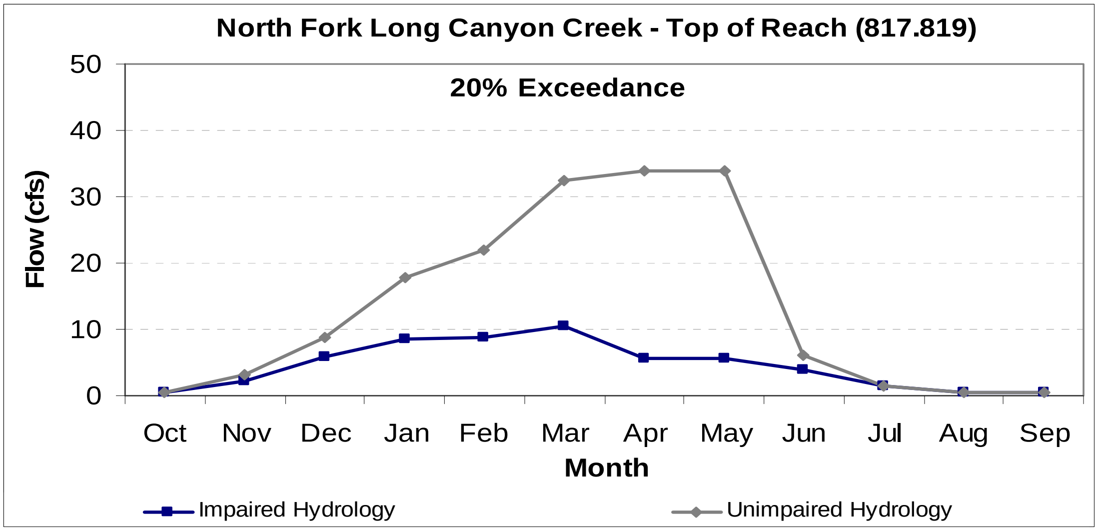
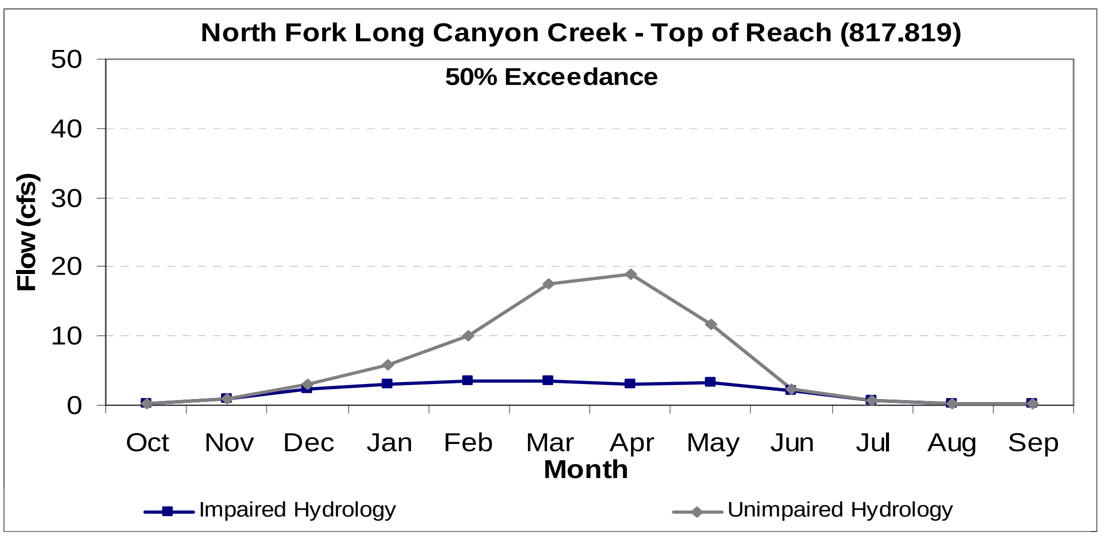


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





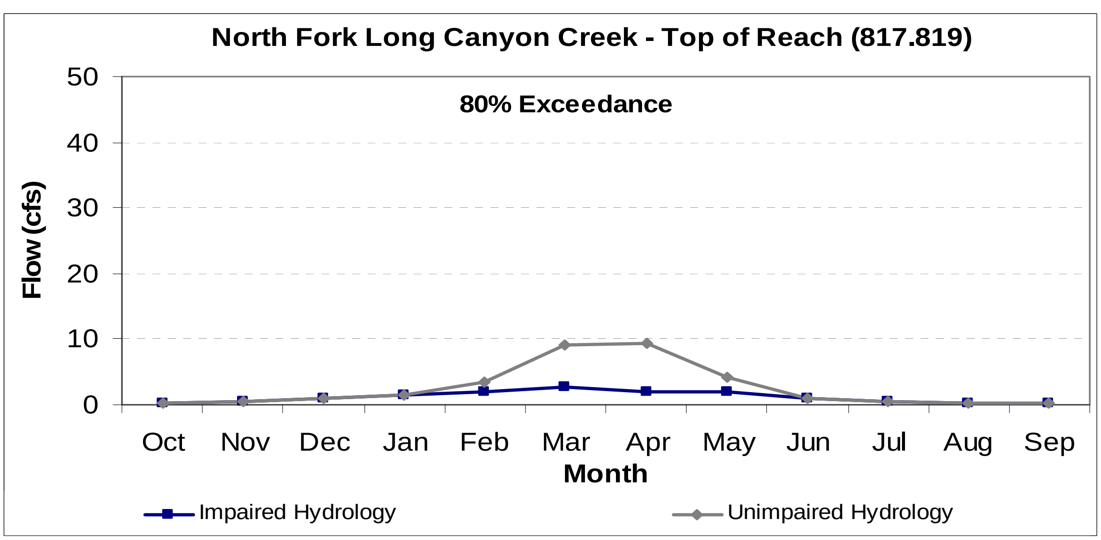
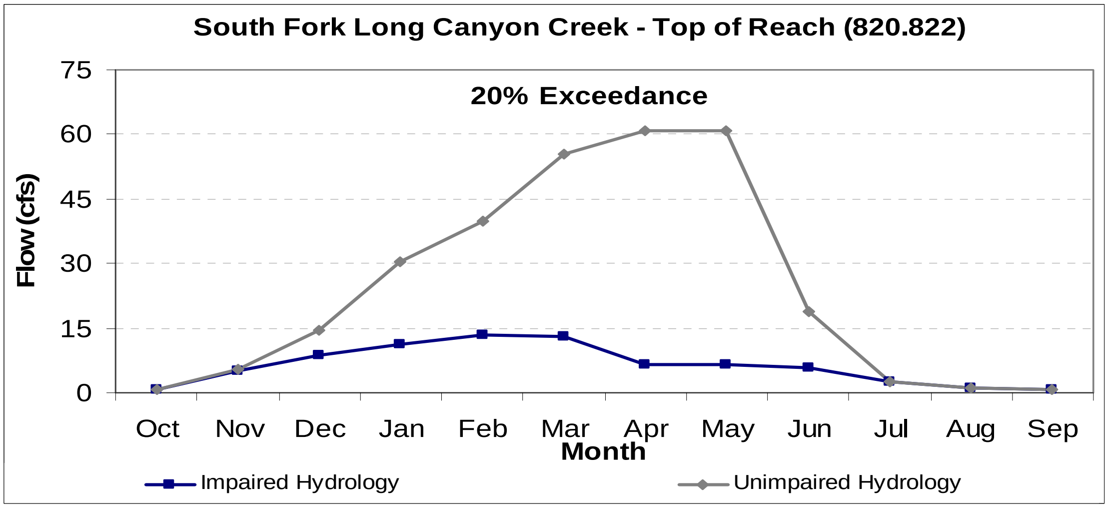
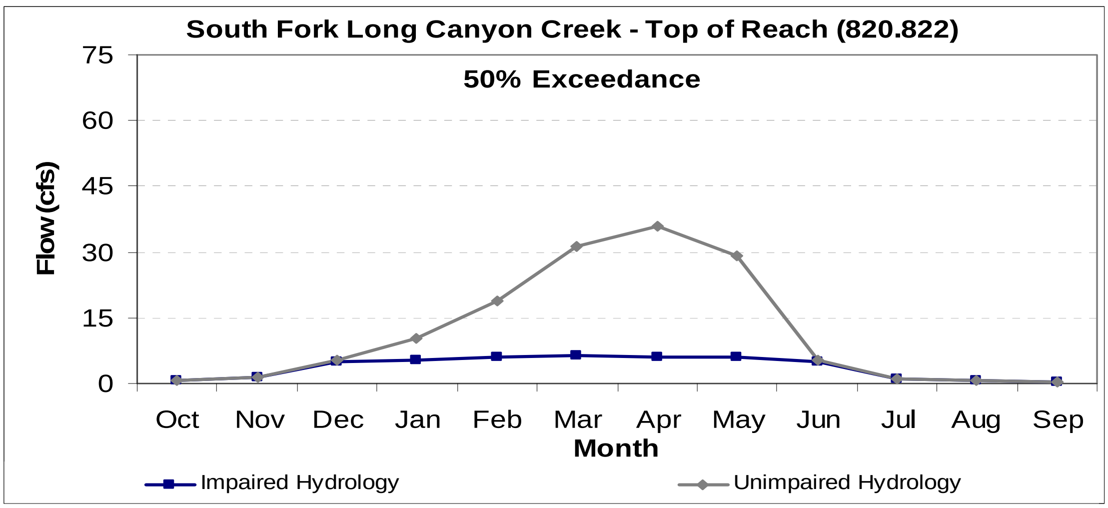
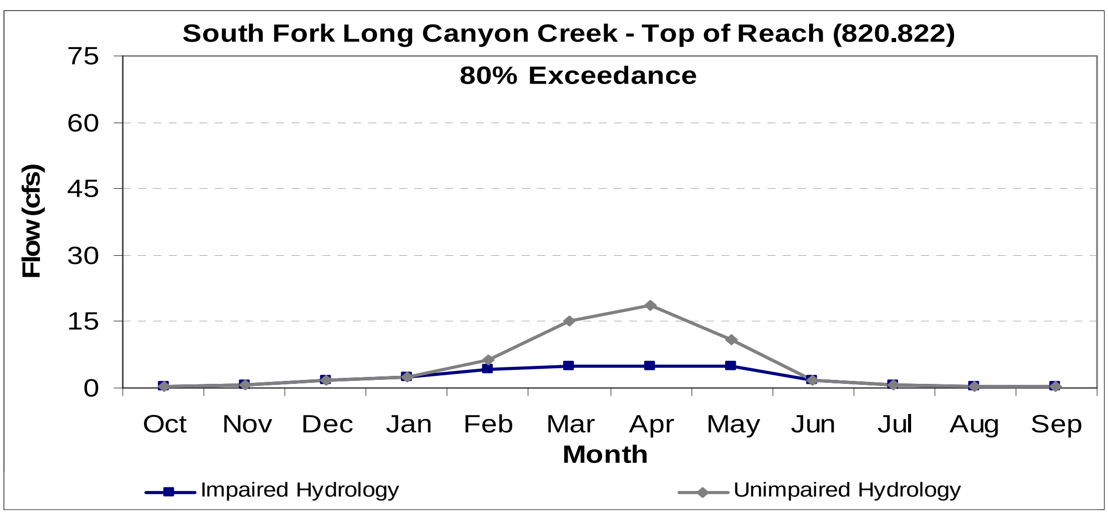


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).







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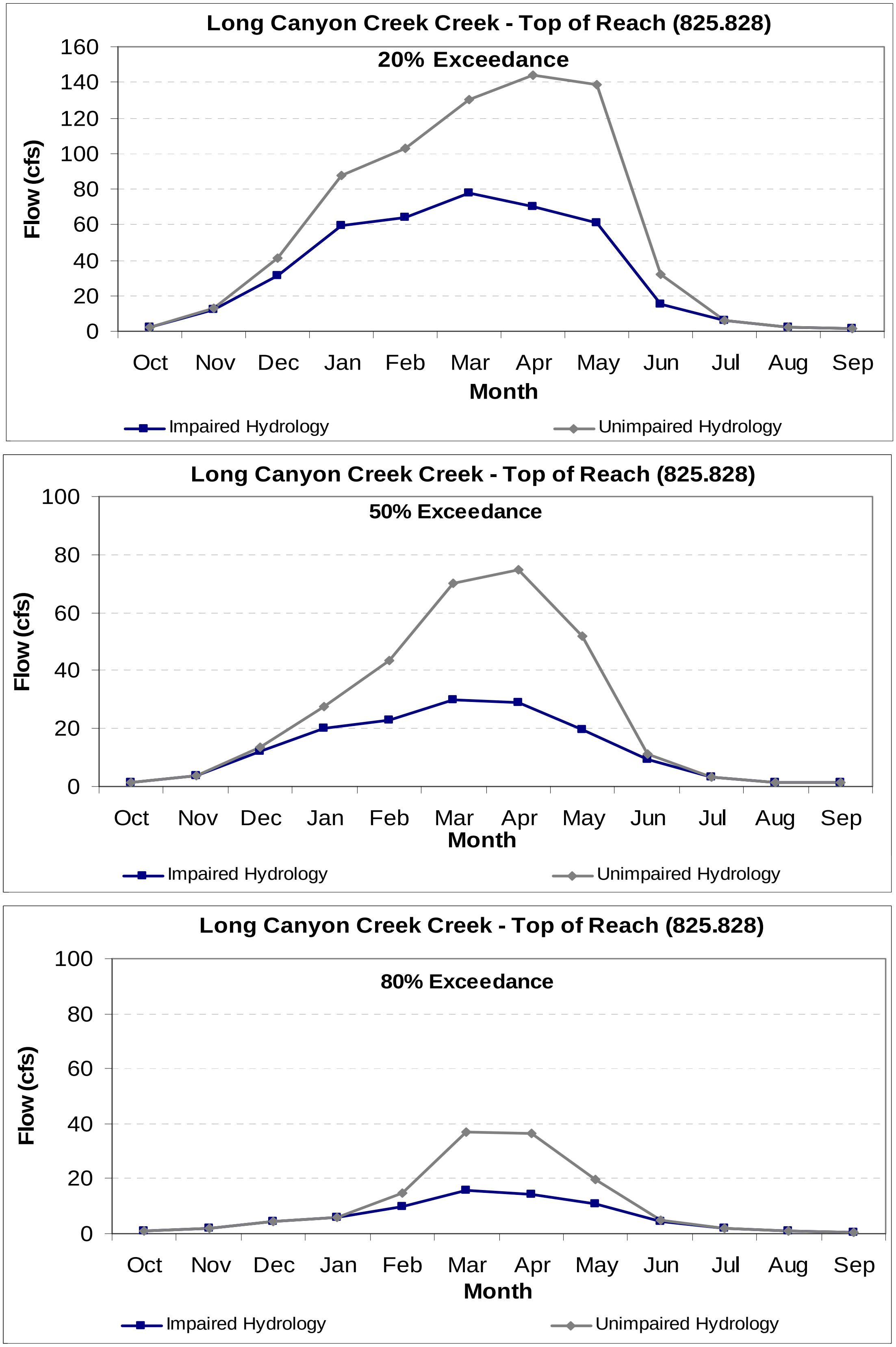
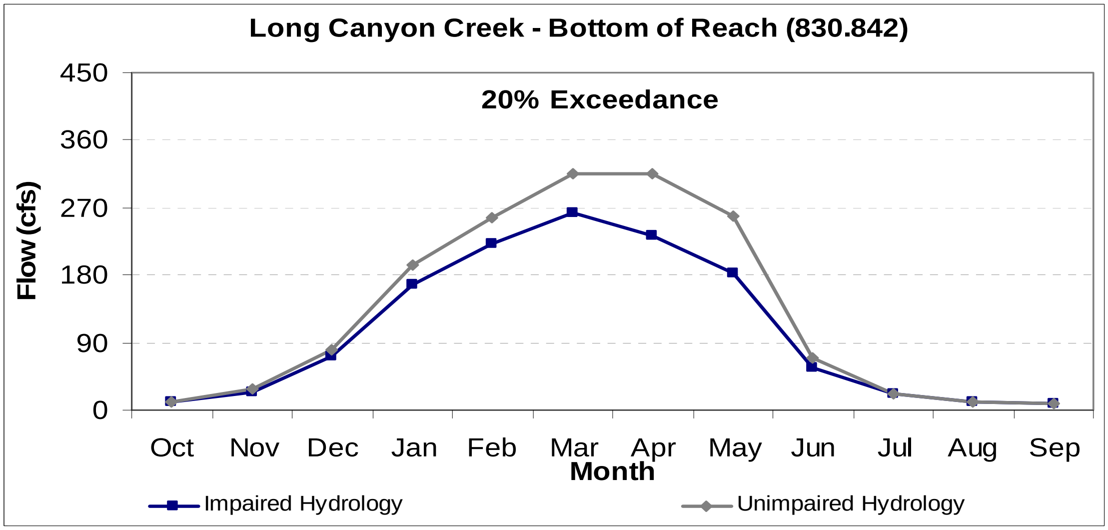
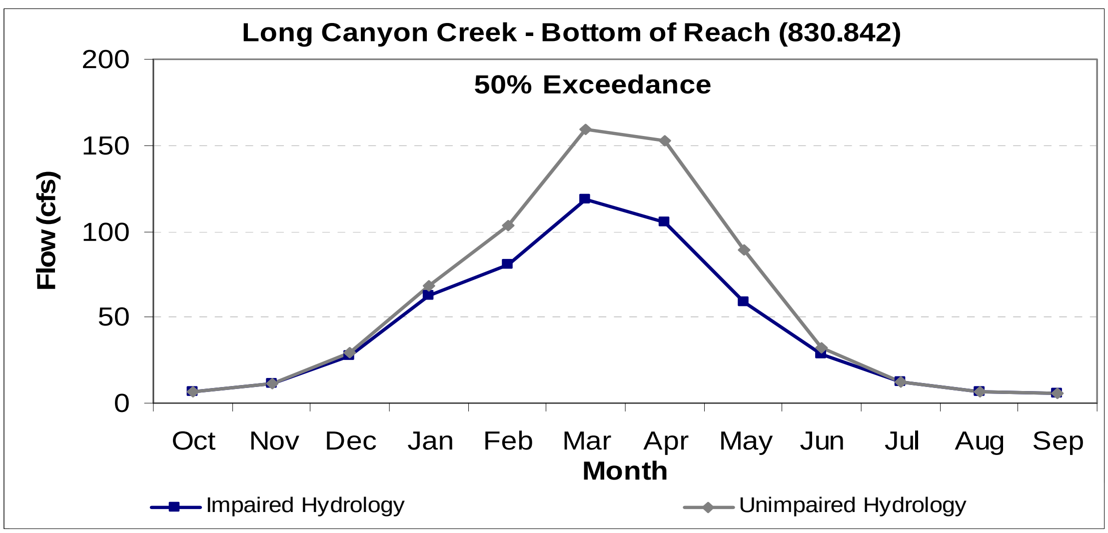


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





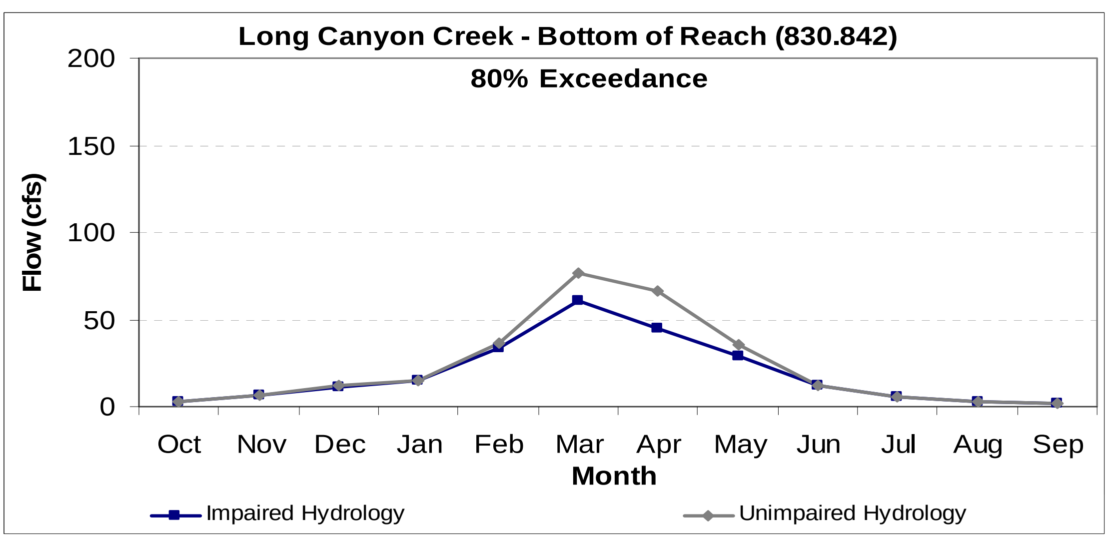
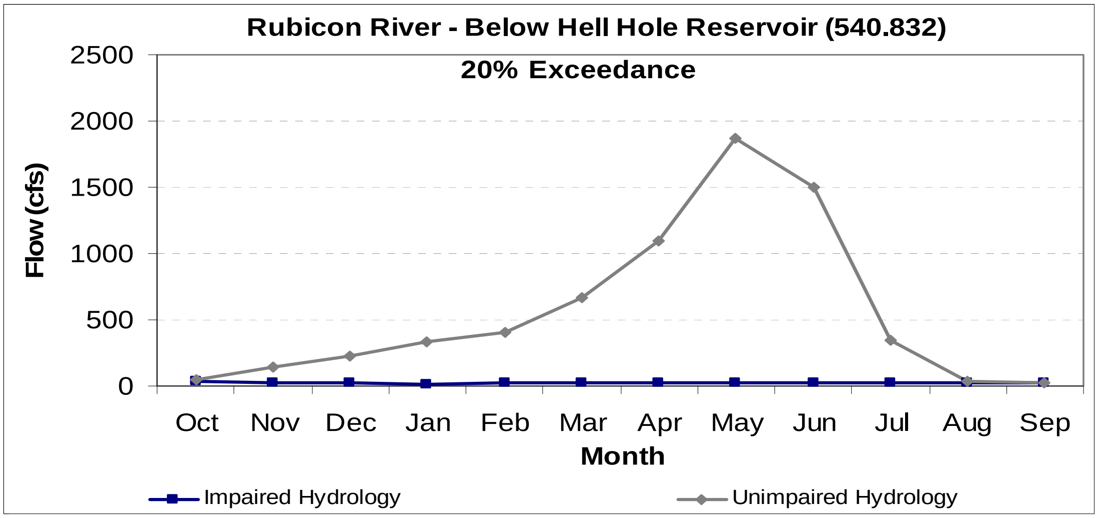
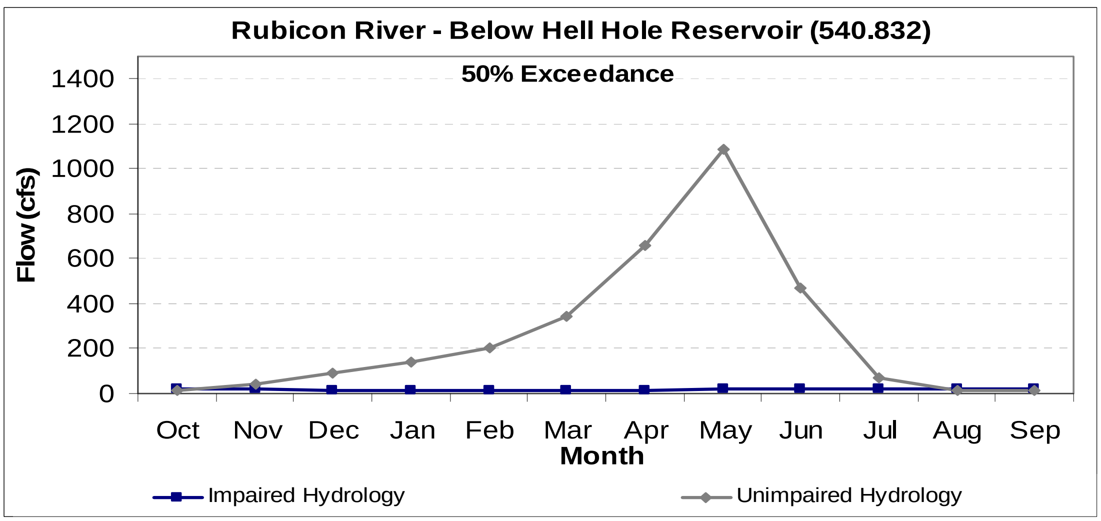


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





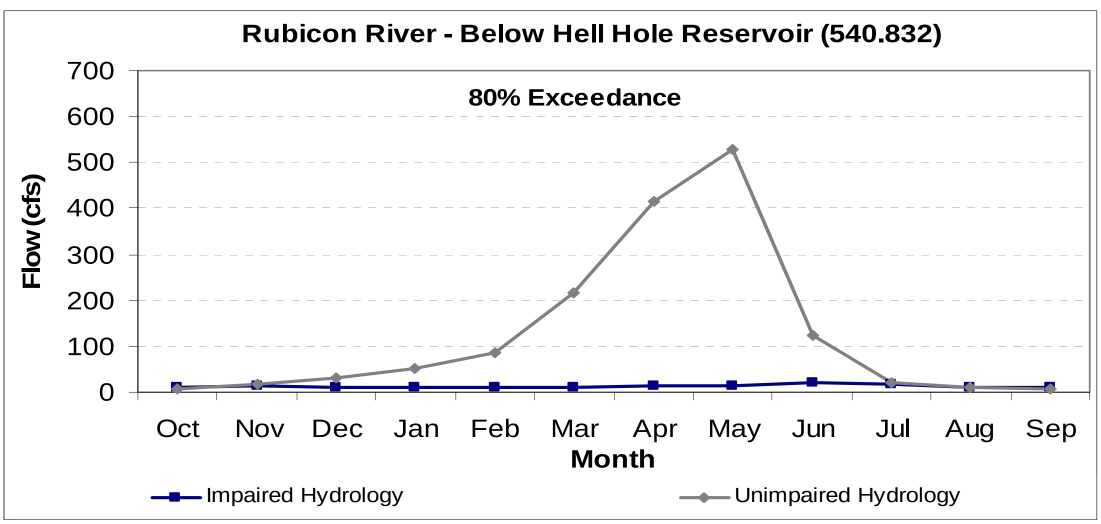
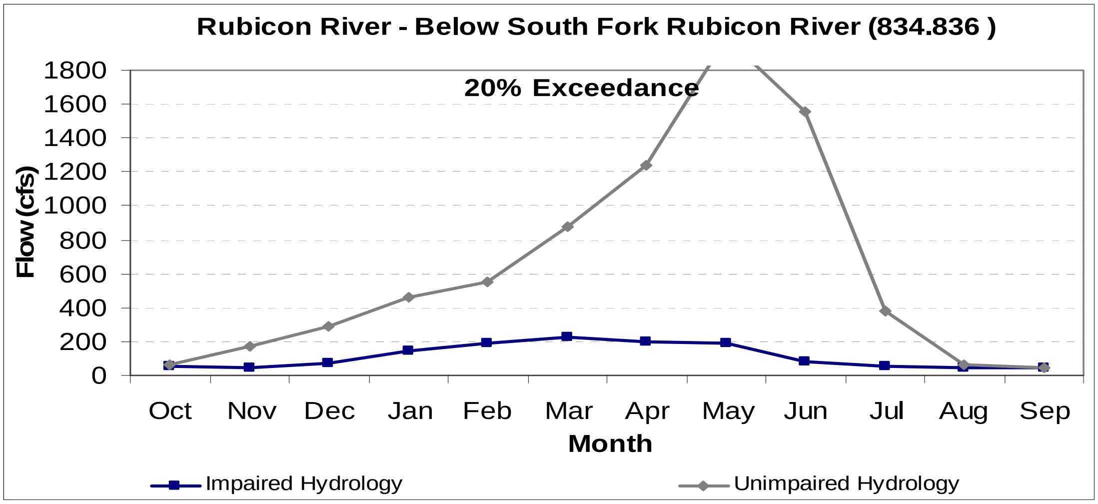
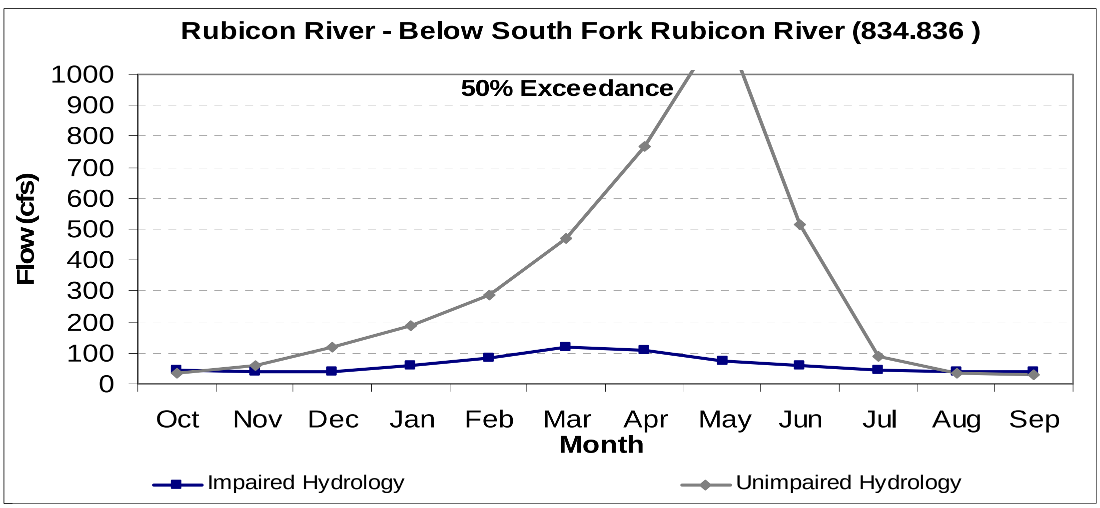


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





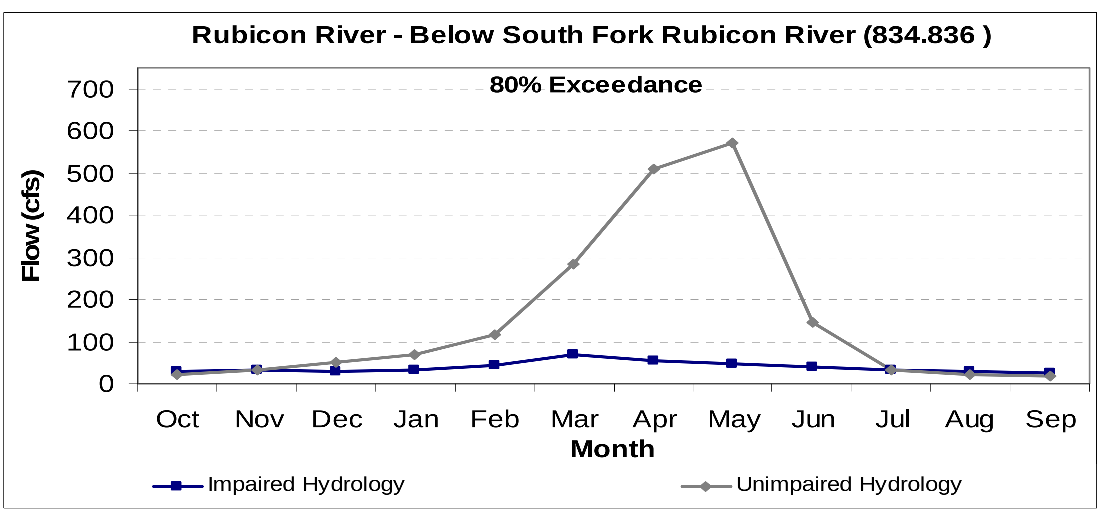
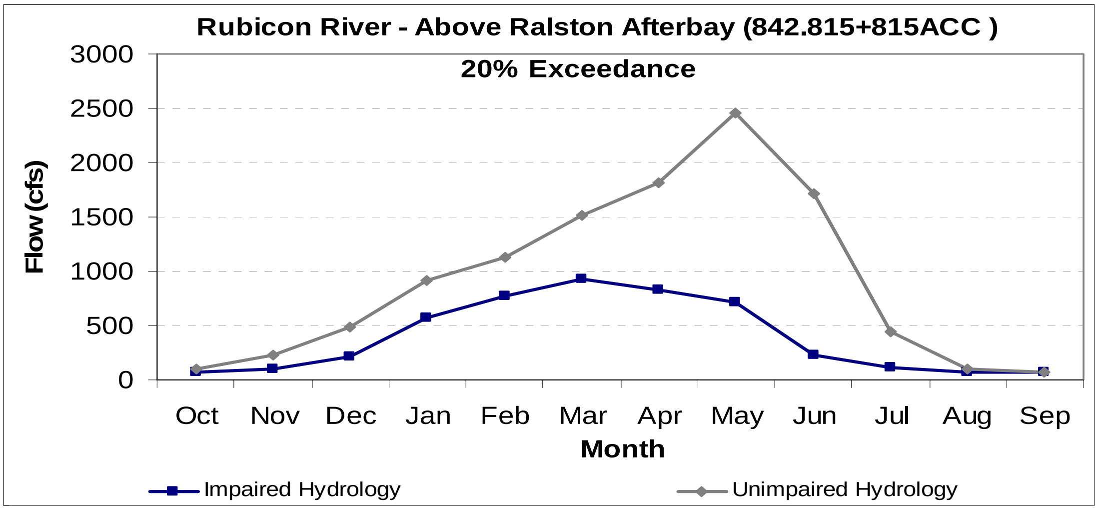
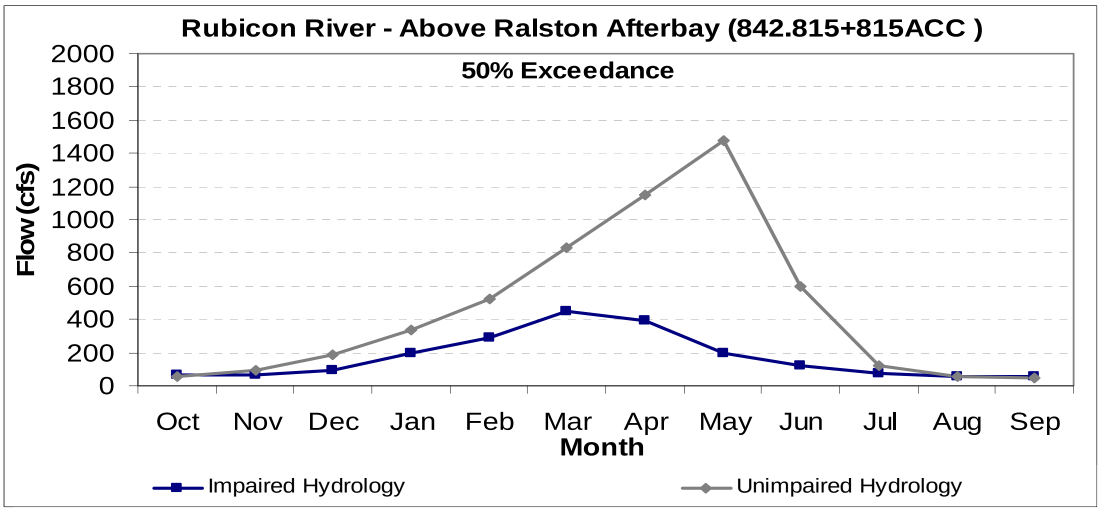


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





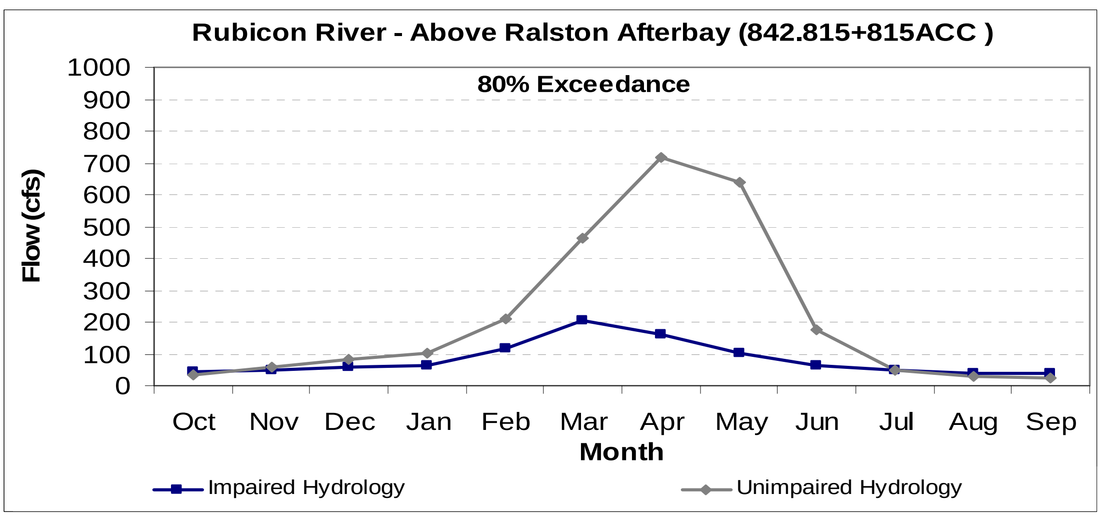
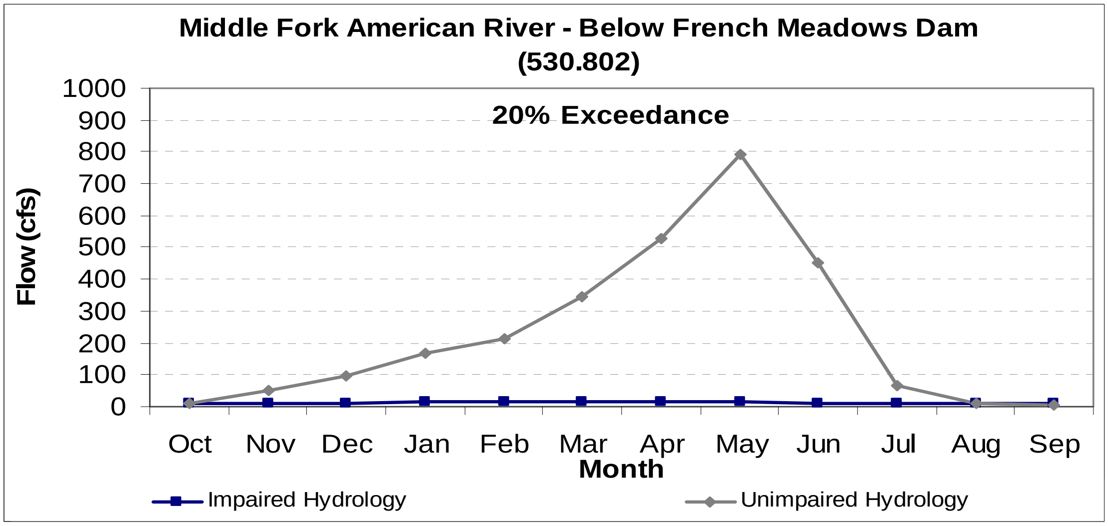
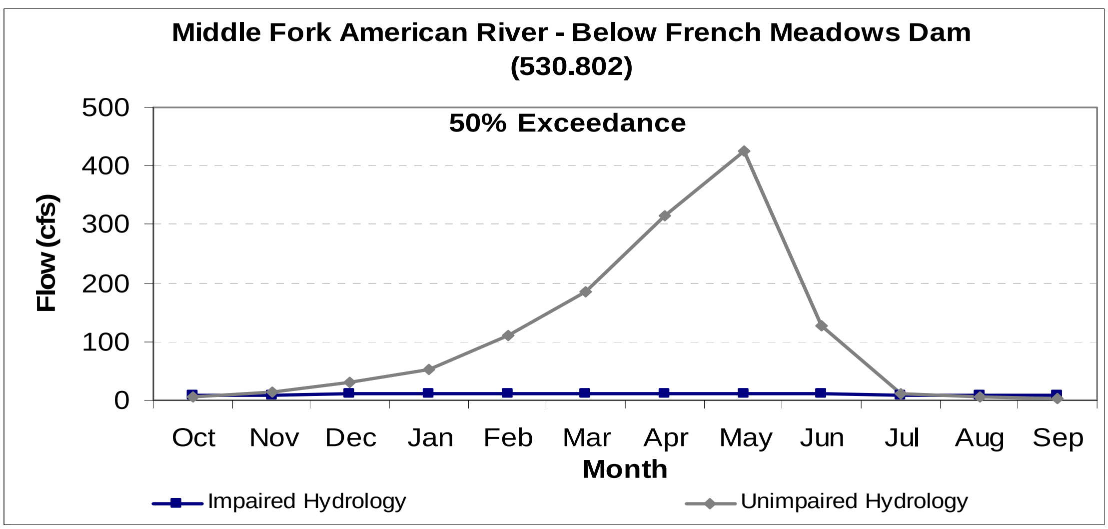


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





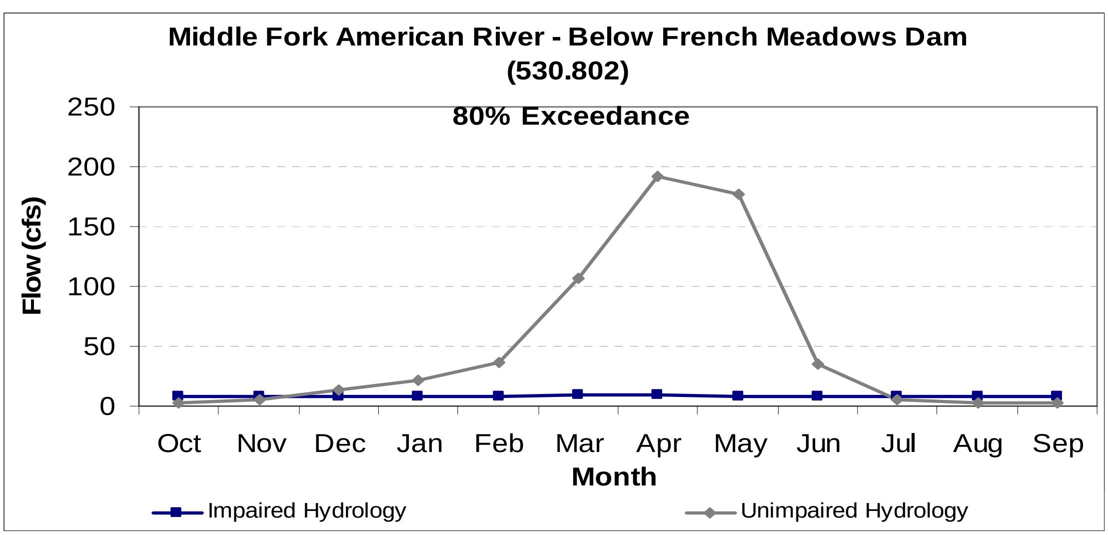
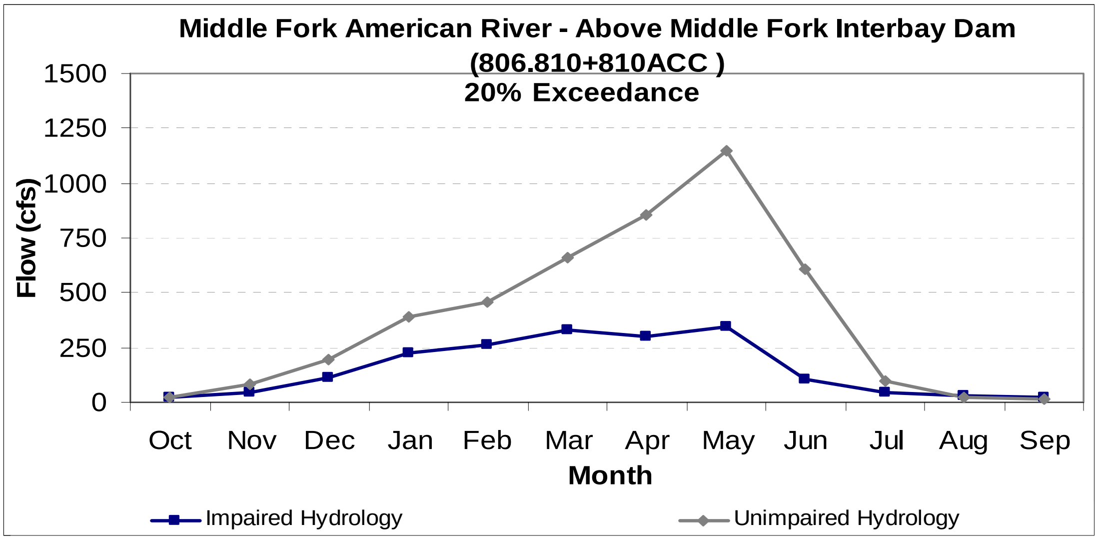
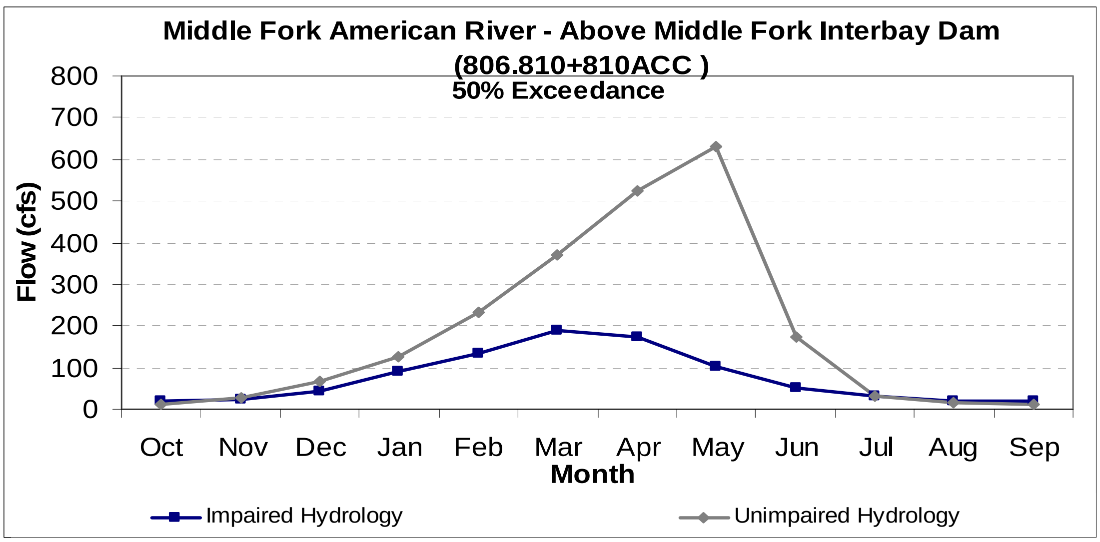


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





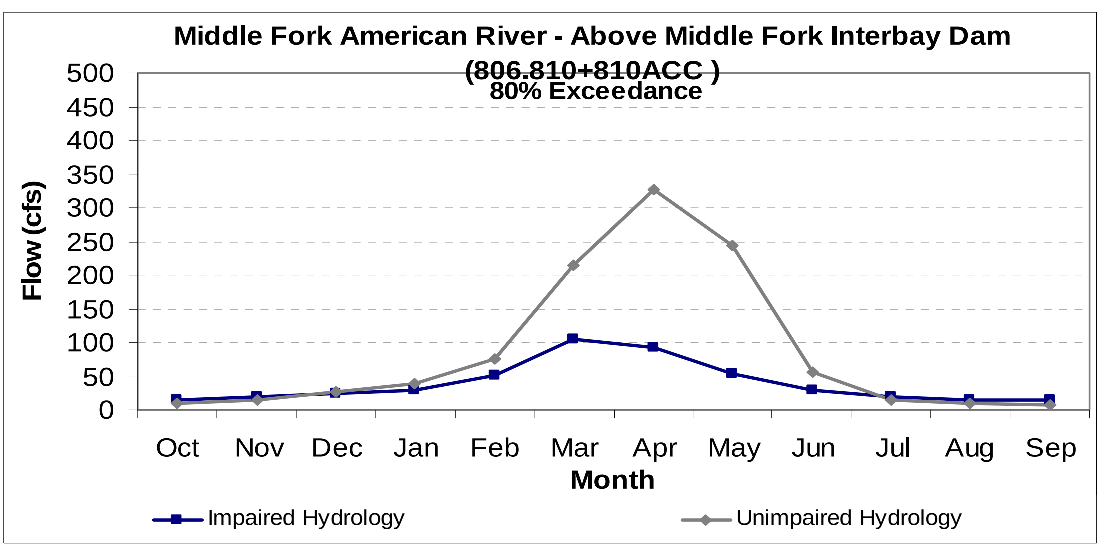
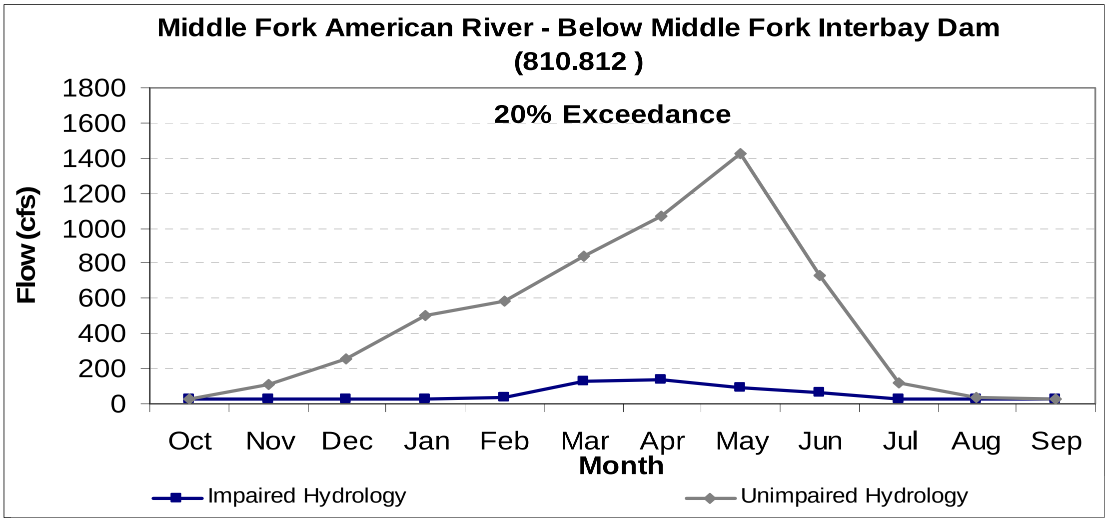
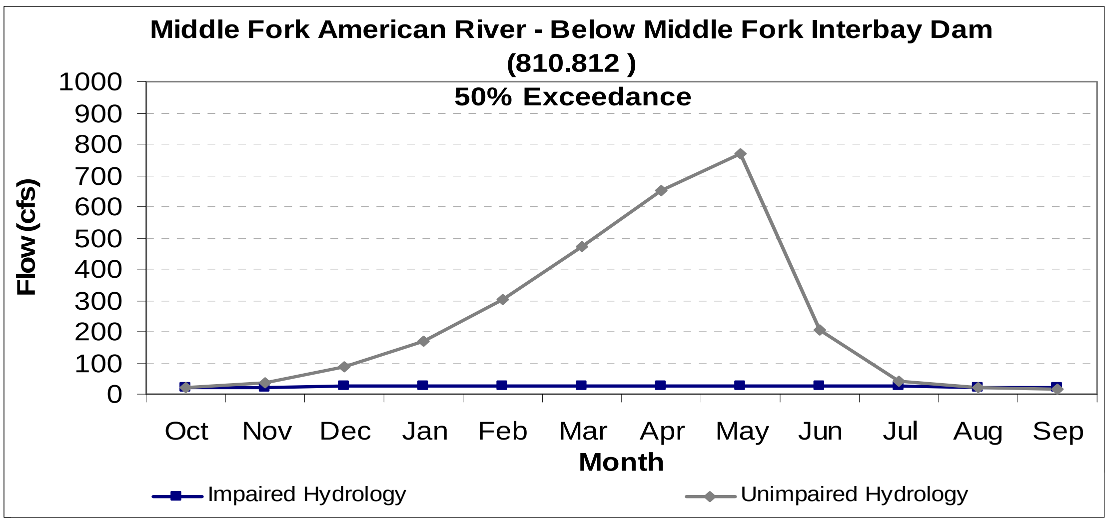


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





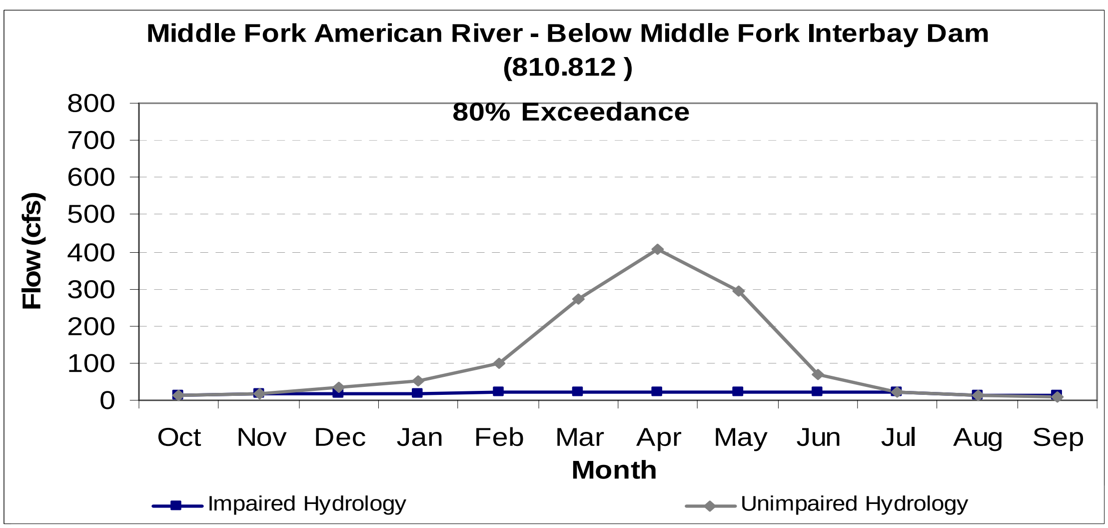
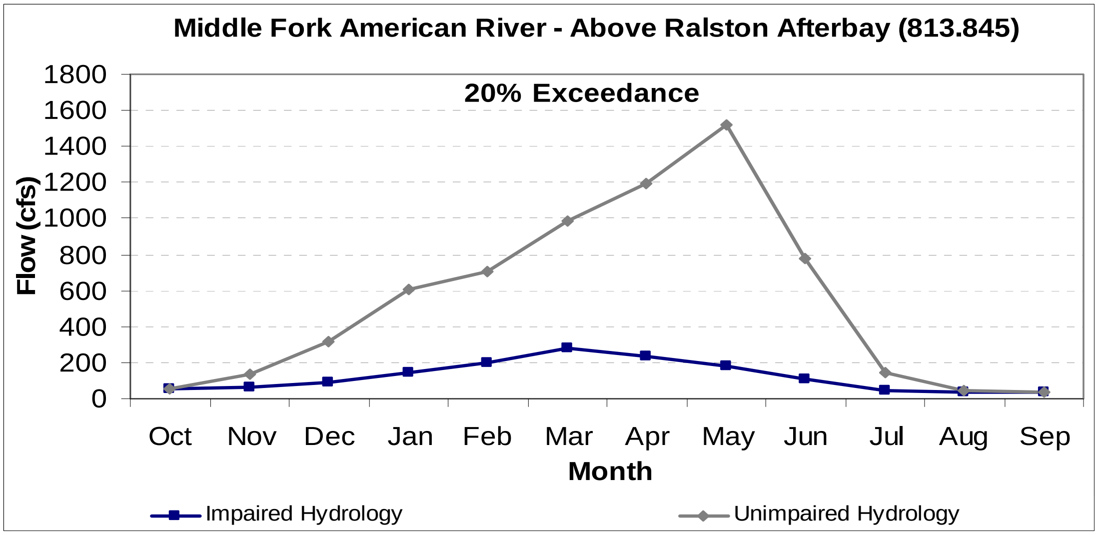
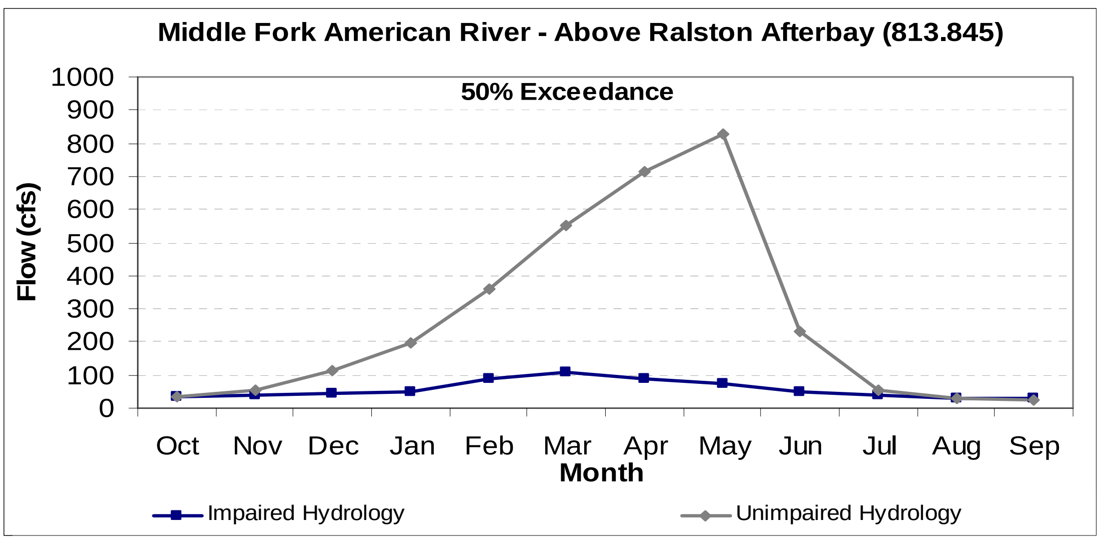


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





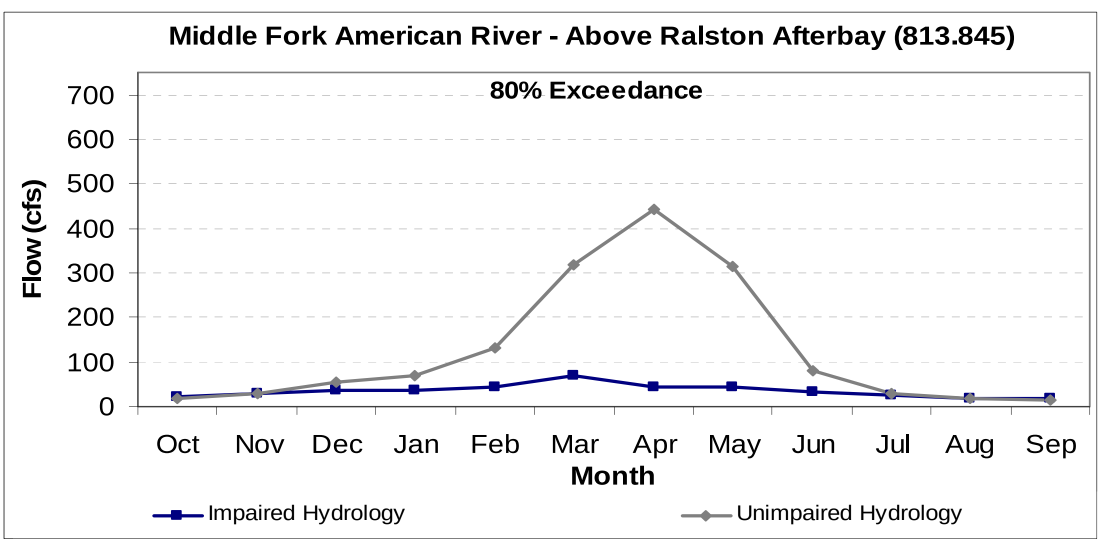


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).

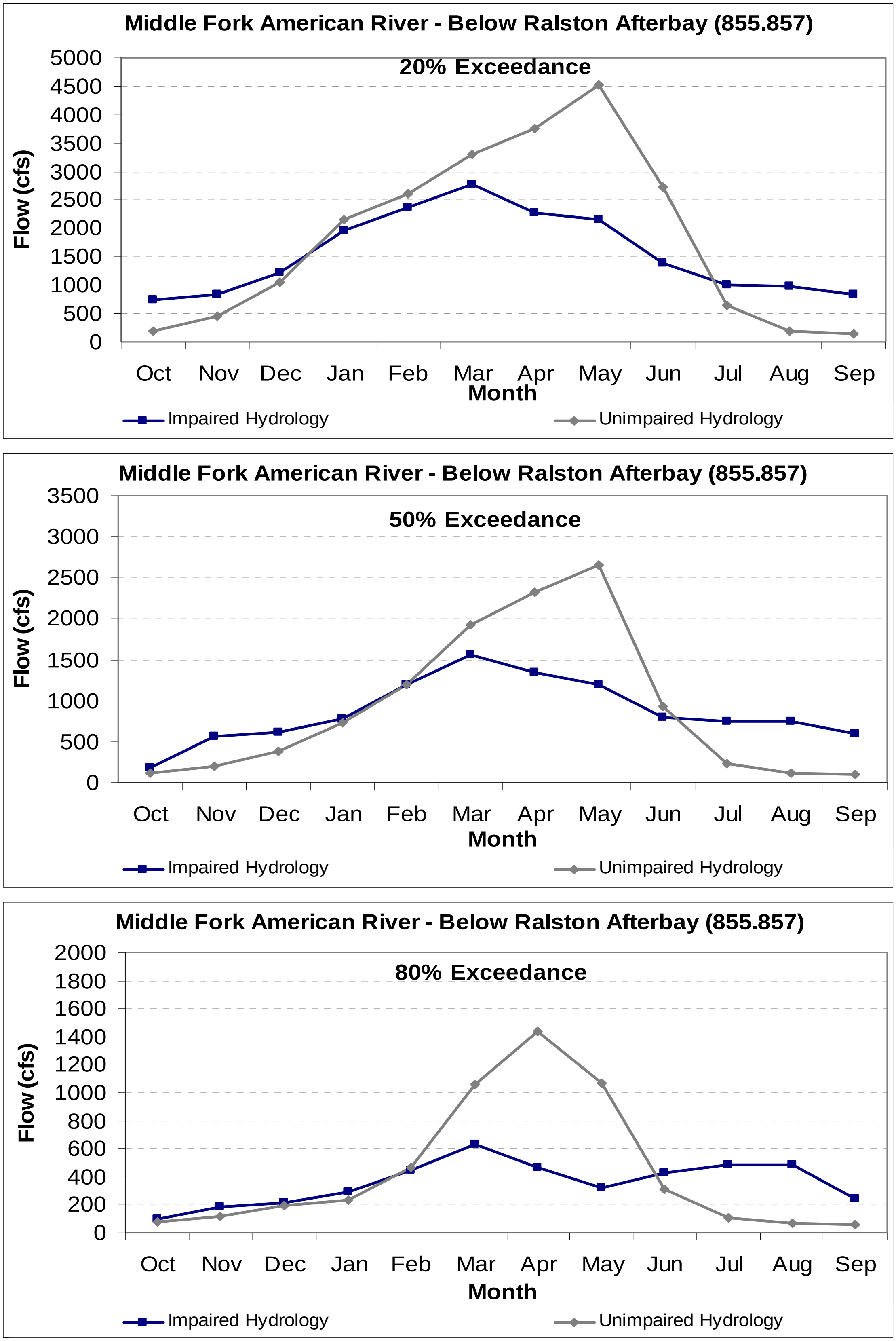
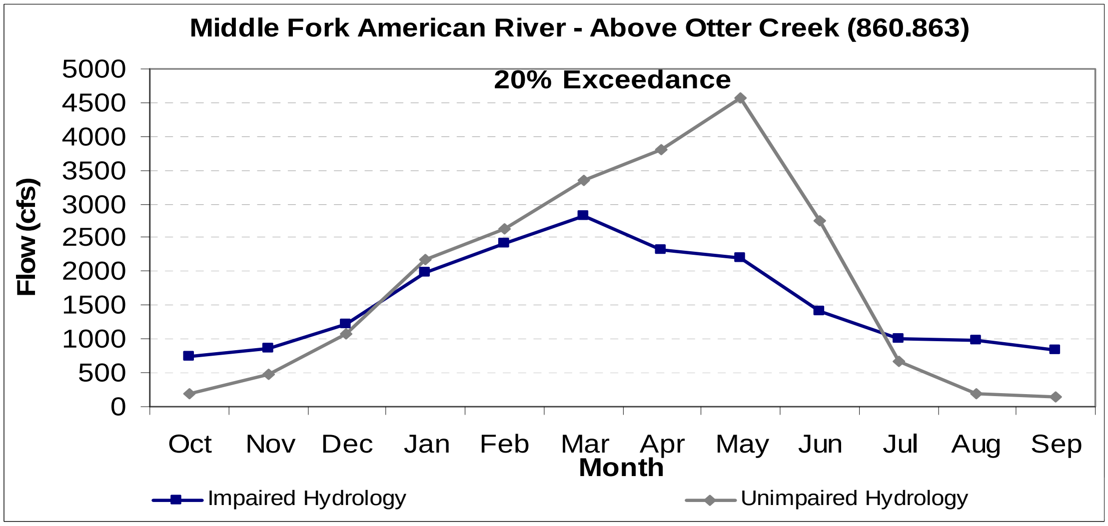
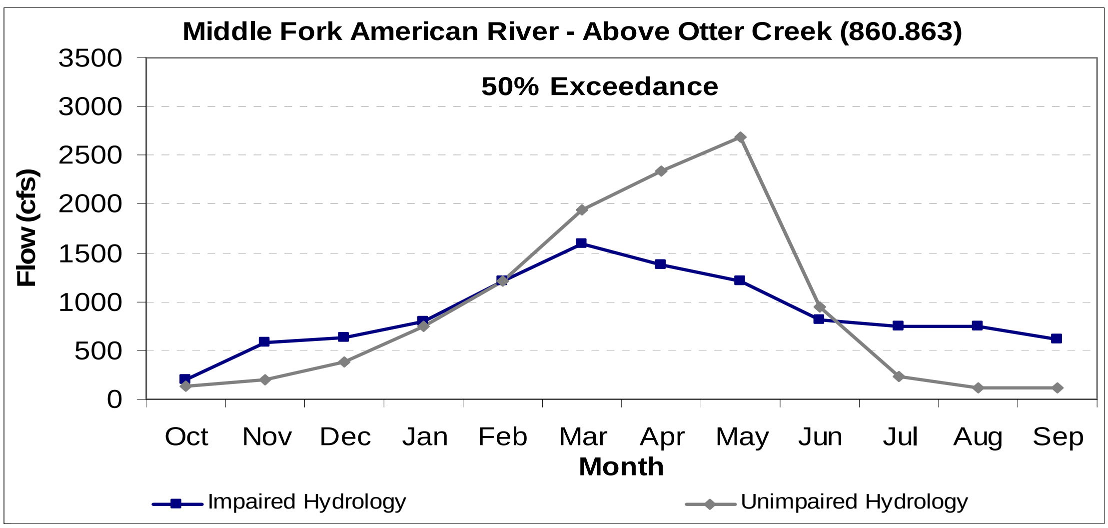


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





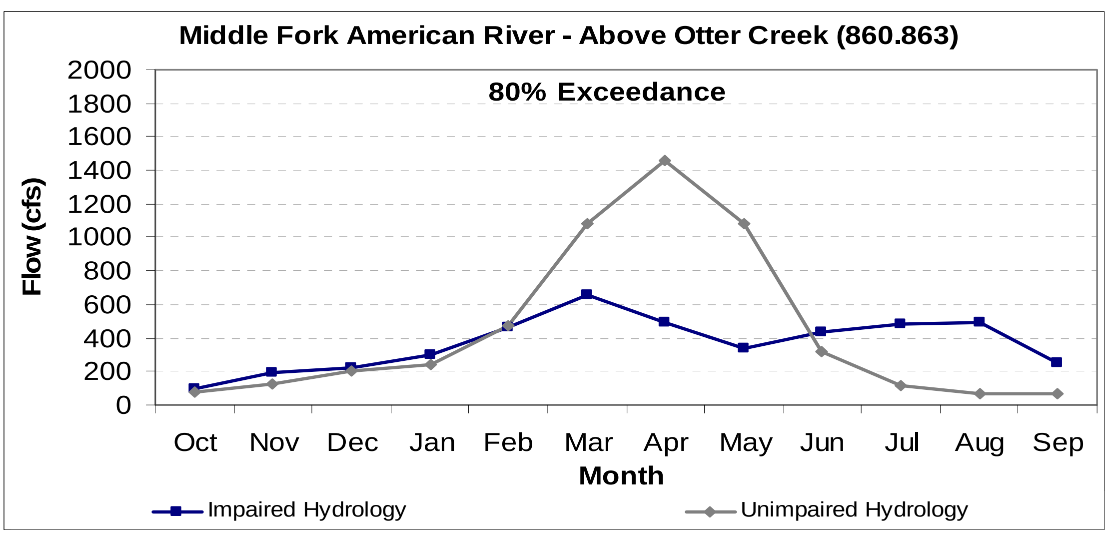
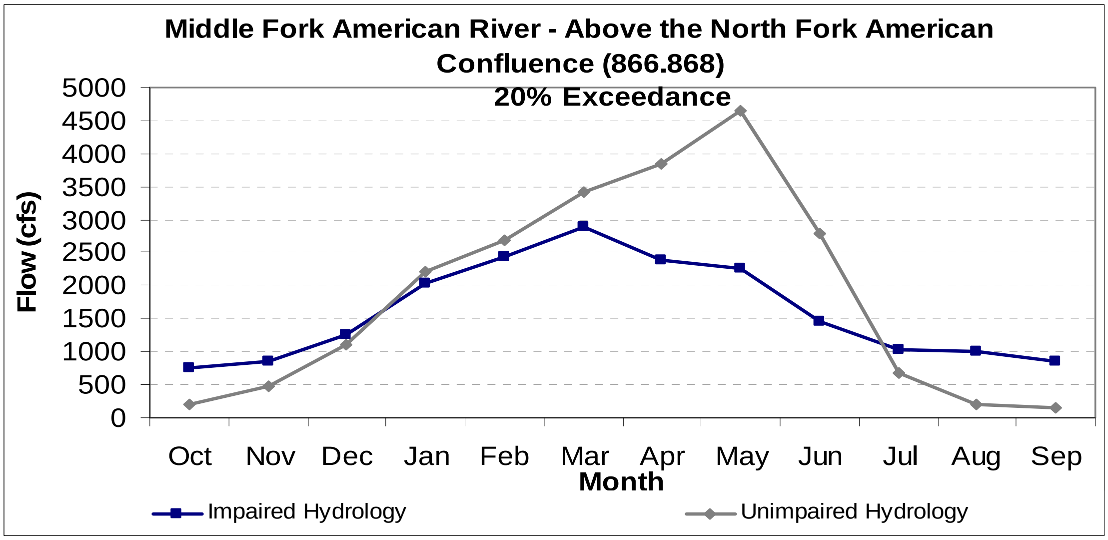
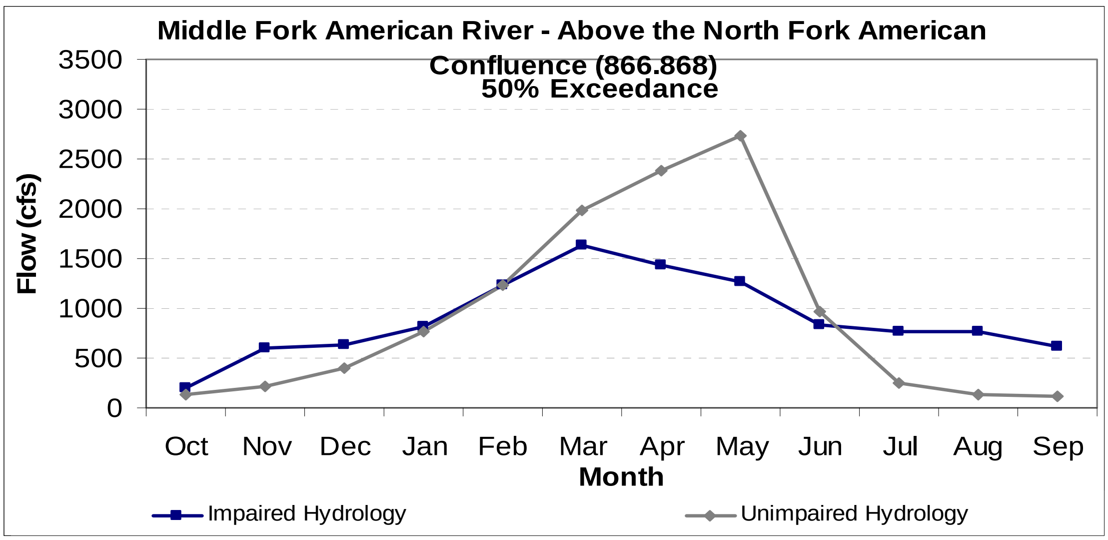


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).





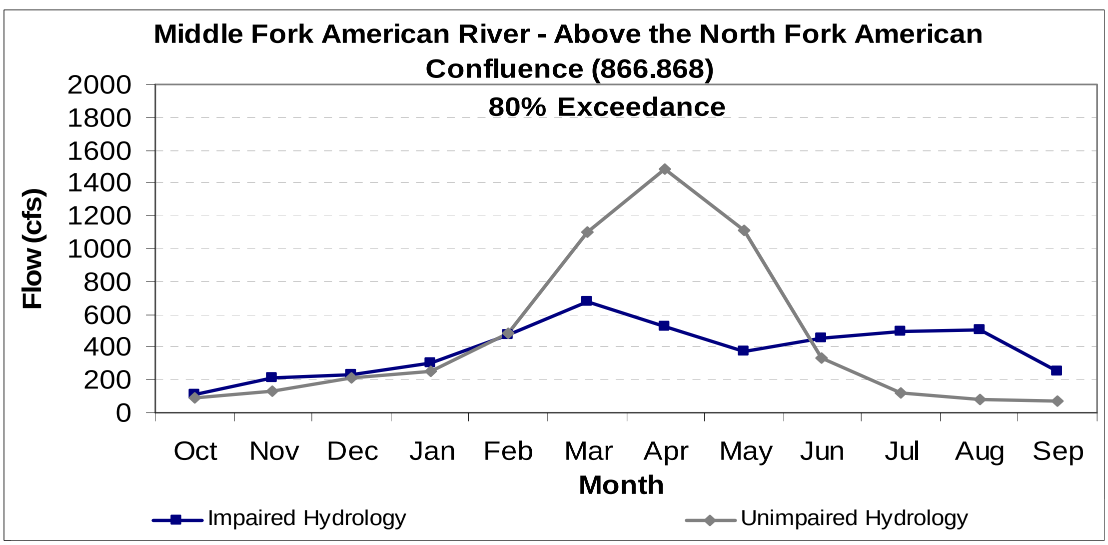
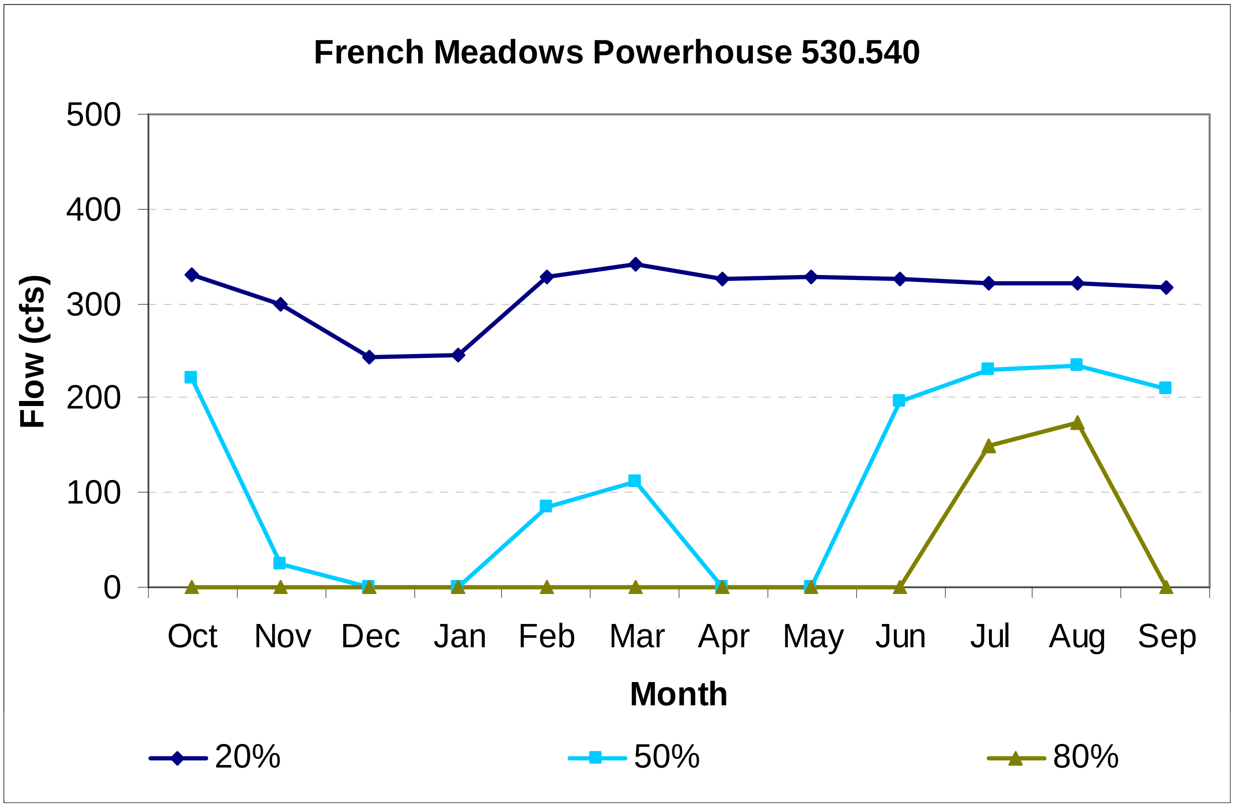


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).



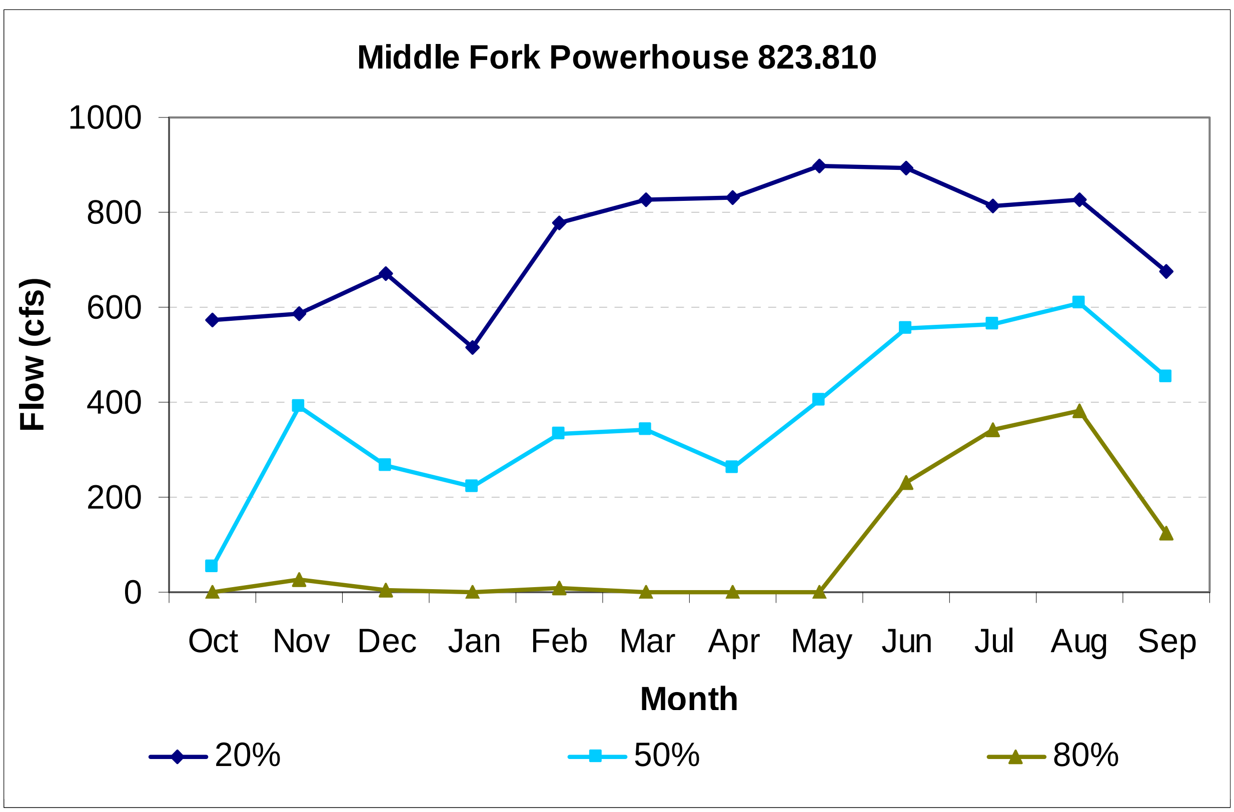
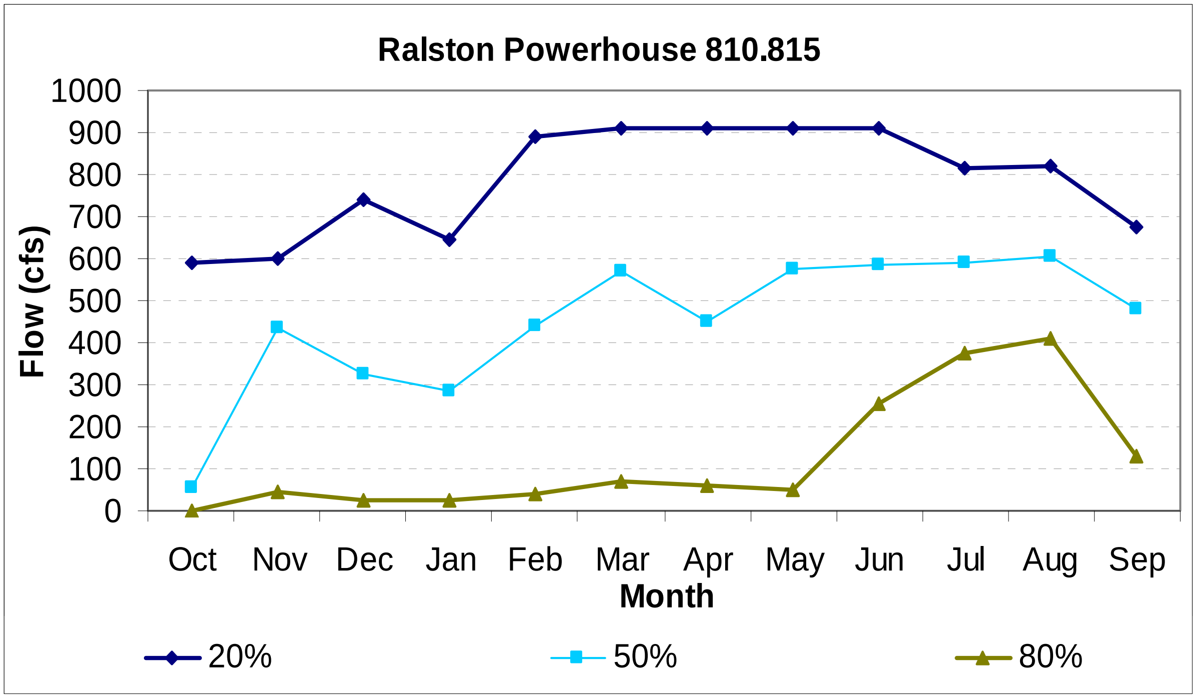


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).



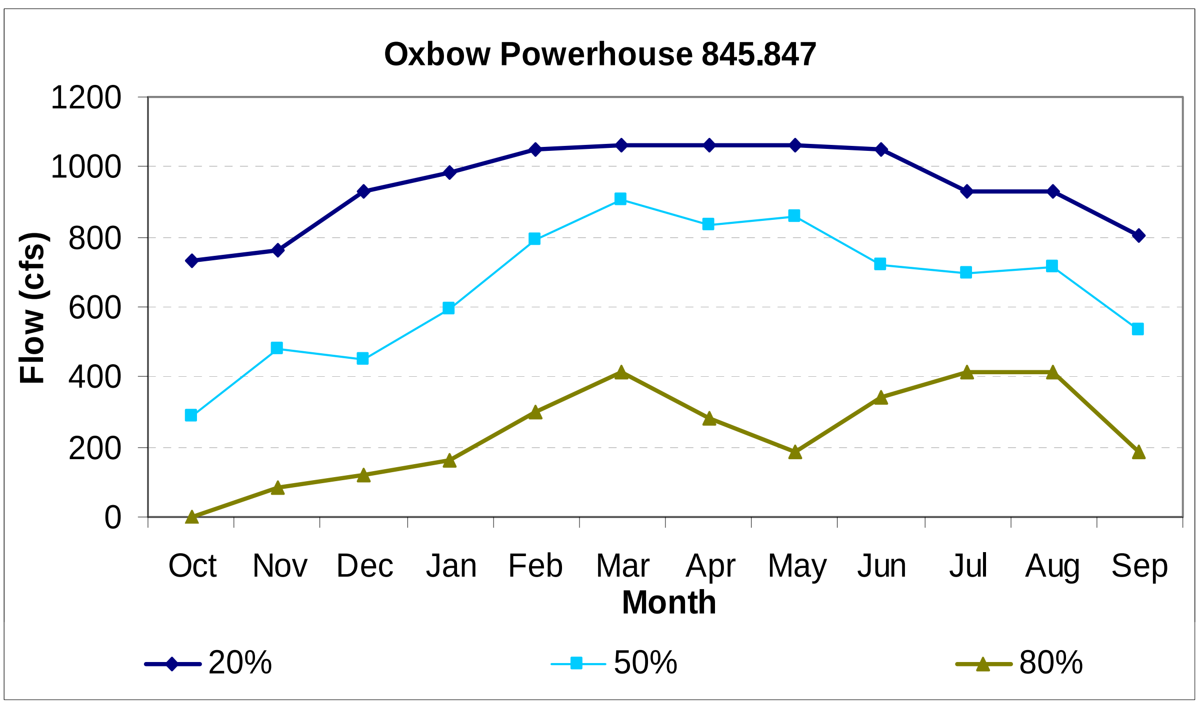
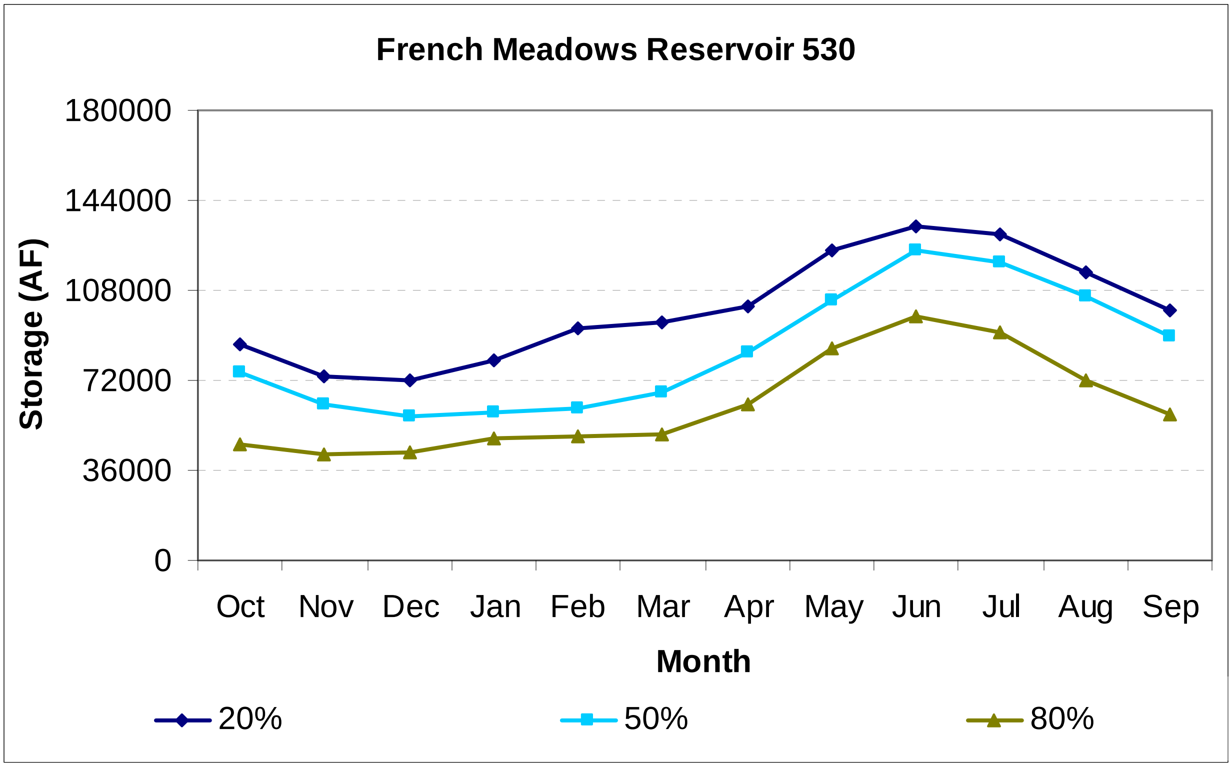


Figure 7.3-4. Graphs of Monthly Exceedance Curves (20%, 50%, and 80%) for Selected Locations in Waters Associated with the Middle Fork American River Project (continued).



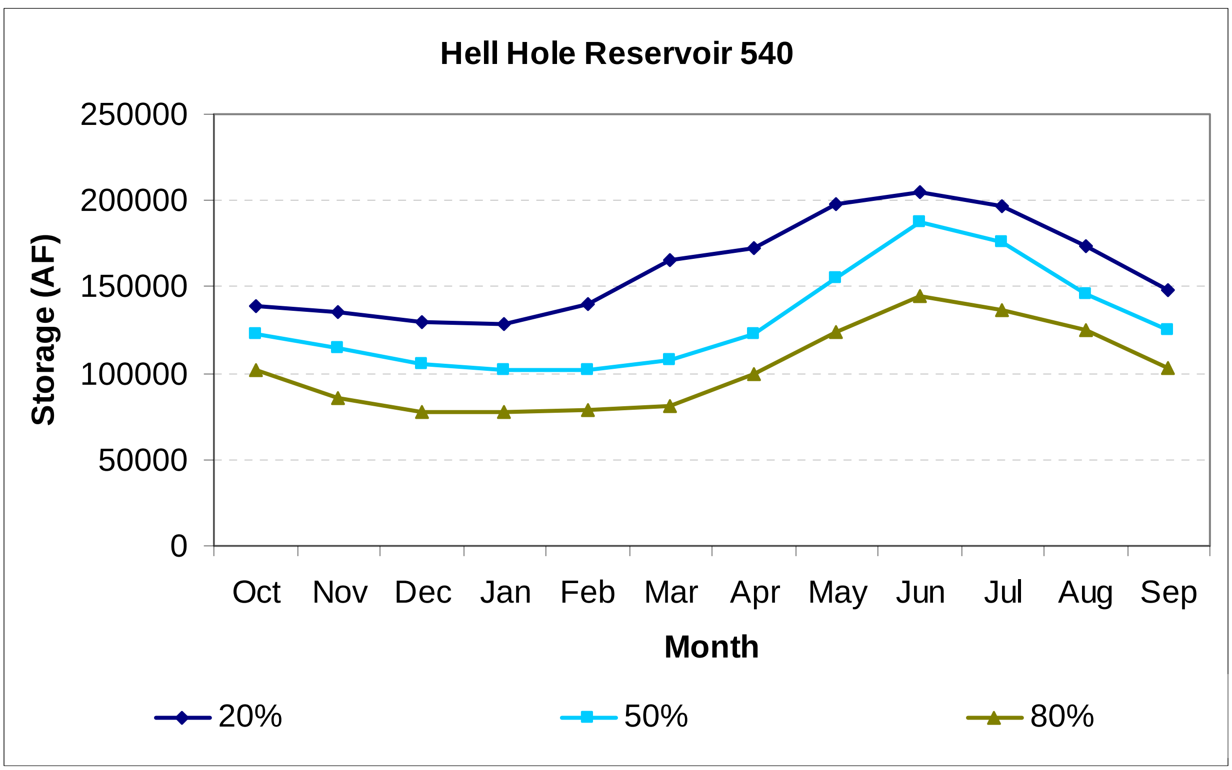
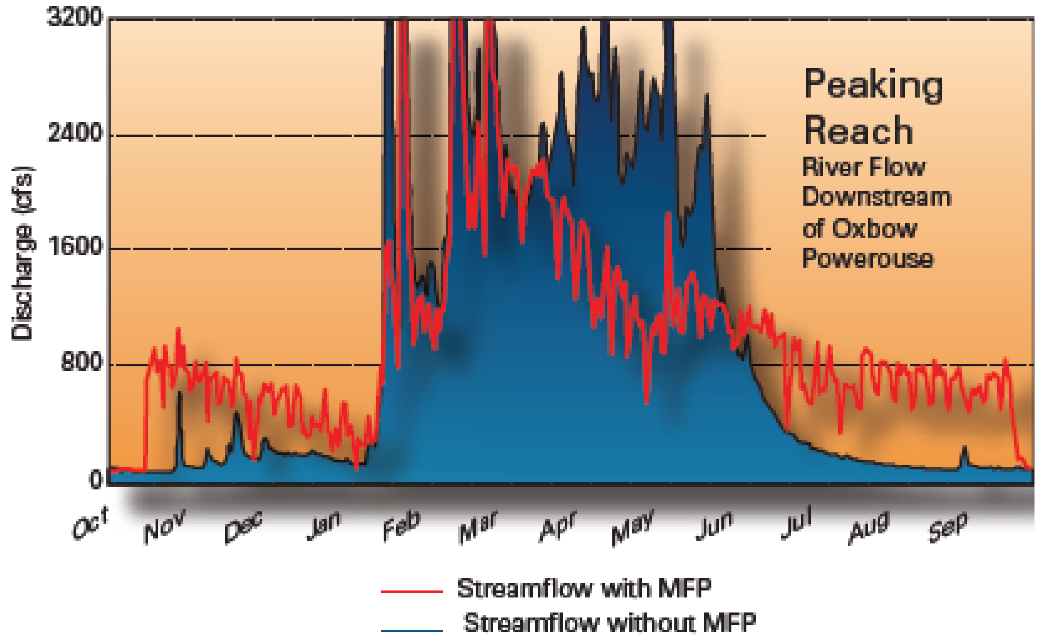


Figure 7.3-5. Example of Project Modification of Flows in the Peaking Reach (Mean Daily Flows).



Note: Peaking operations at Oxbow Powerhouse may result in substantial fluctuations of flow in the peaking reach.

Figure 7.3-6. Idealized Examples of Releases from Oxbow Powerhouse During Wet, Above Normal, Below Normal, Dry, and Critical Years.

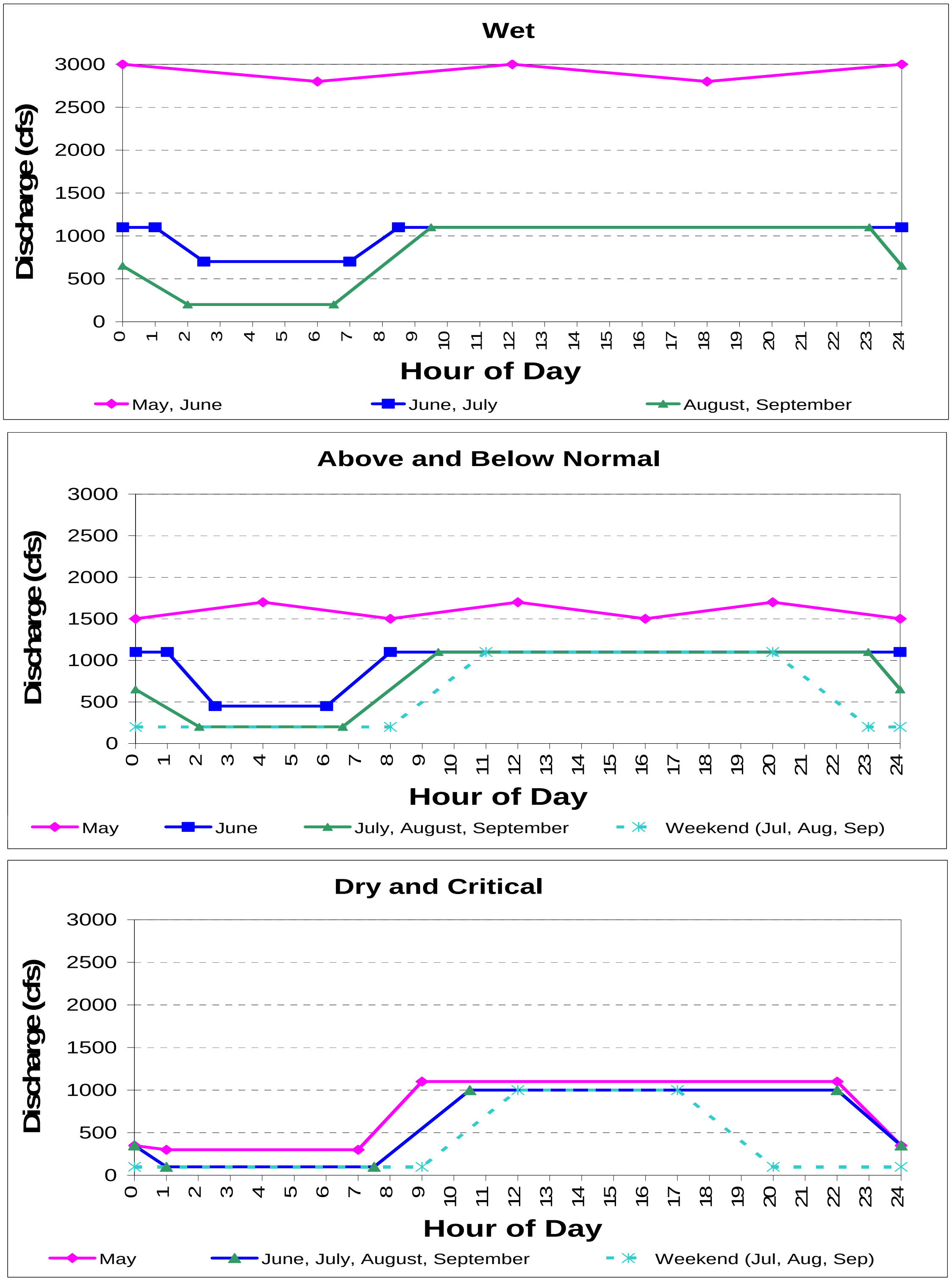


Figure 7.3-7. Base Flow/Travel Velocity Relationship for the Peaking Reach.

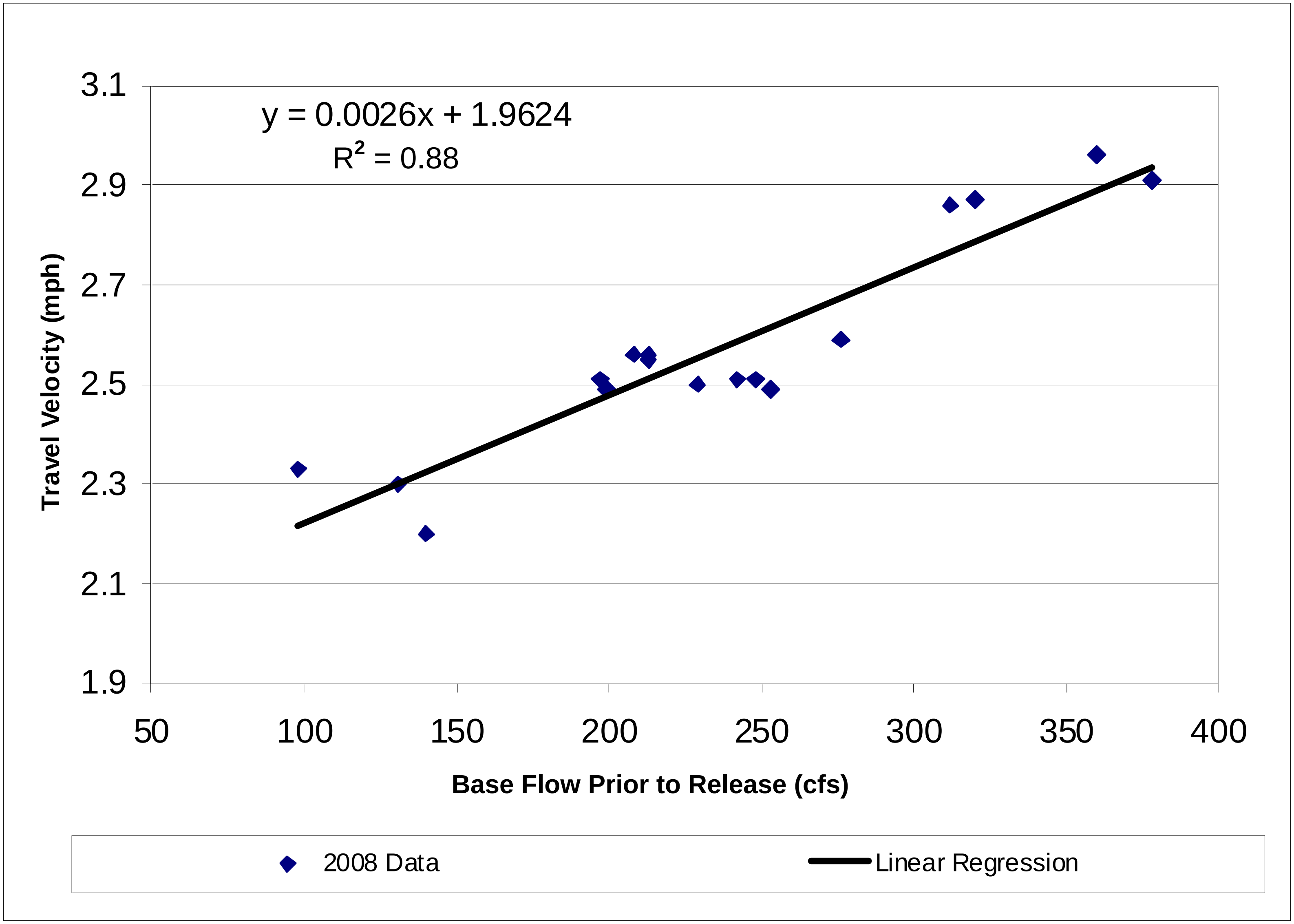
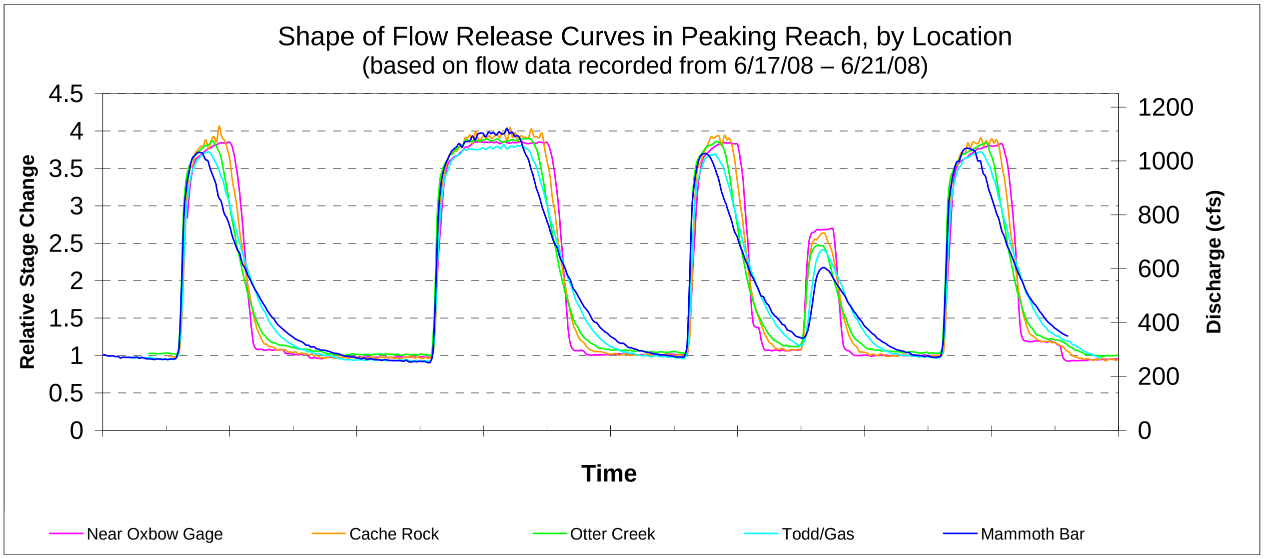


Figure 7.3-8. Shape of Flow Release Curves in Peaking Reach by Location.



This figure shows the shape of the flow release curves at different locations in the peaking reach. Each curve has been shifted to overlie the curve near the Oxbow gage to illustrate the following points:

- In general, the up-ramp from low base flow to high peaking flow, in terms of discharge (e.g., change in cfs per hour) remains the same throughout the reach.
- The shape of the flow release curve changes with location in the peaking reach. The farther downstream, the narrower the width of the top of the curve and the slower the down-ramp.
- The slope of the down-ramp changes as the peak travels downstream. At the top of the reach, the down-ramps are relatively rapid with decreases in flow at a rate similar to the up-ramp rate (250 to 450 cfs/hr, 3 hours to down-ramp). Down-ramps are slower and have a longer duration (slower down-ramp rate) depending on the distance down stream.
- Note that the x axis does not include a scaled because the curves have been shifted for comparison purposes.

Figure 7.3-9. French Meadows Reservoir Storage Capacity Curve.

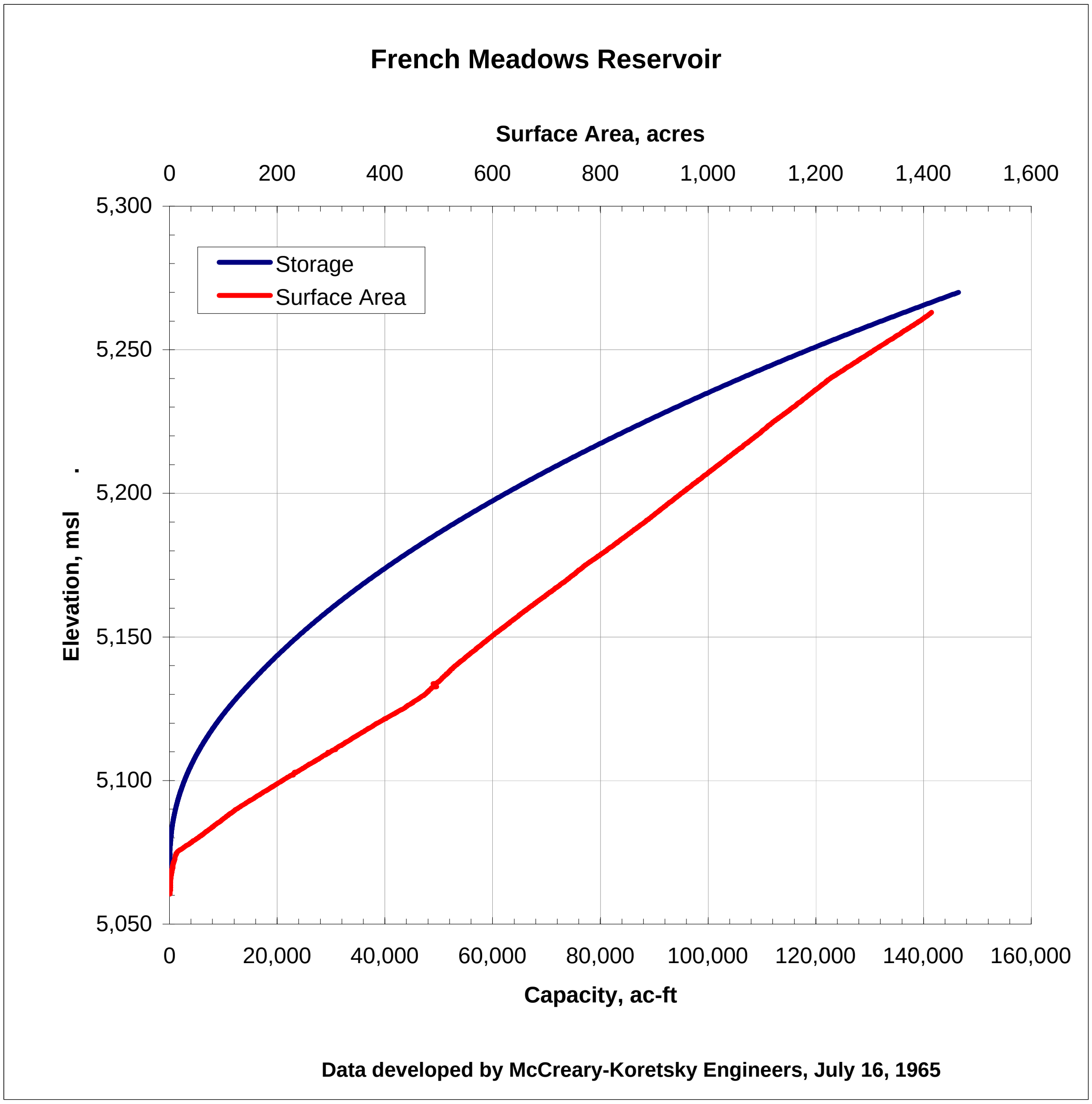


Figure 7.3-10. Hell Hole Reservoir Storage Capacity Curve.

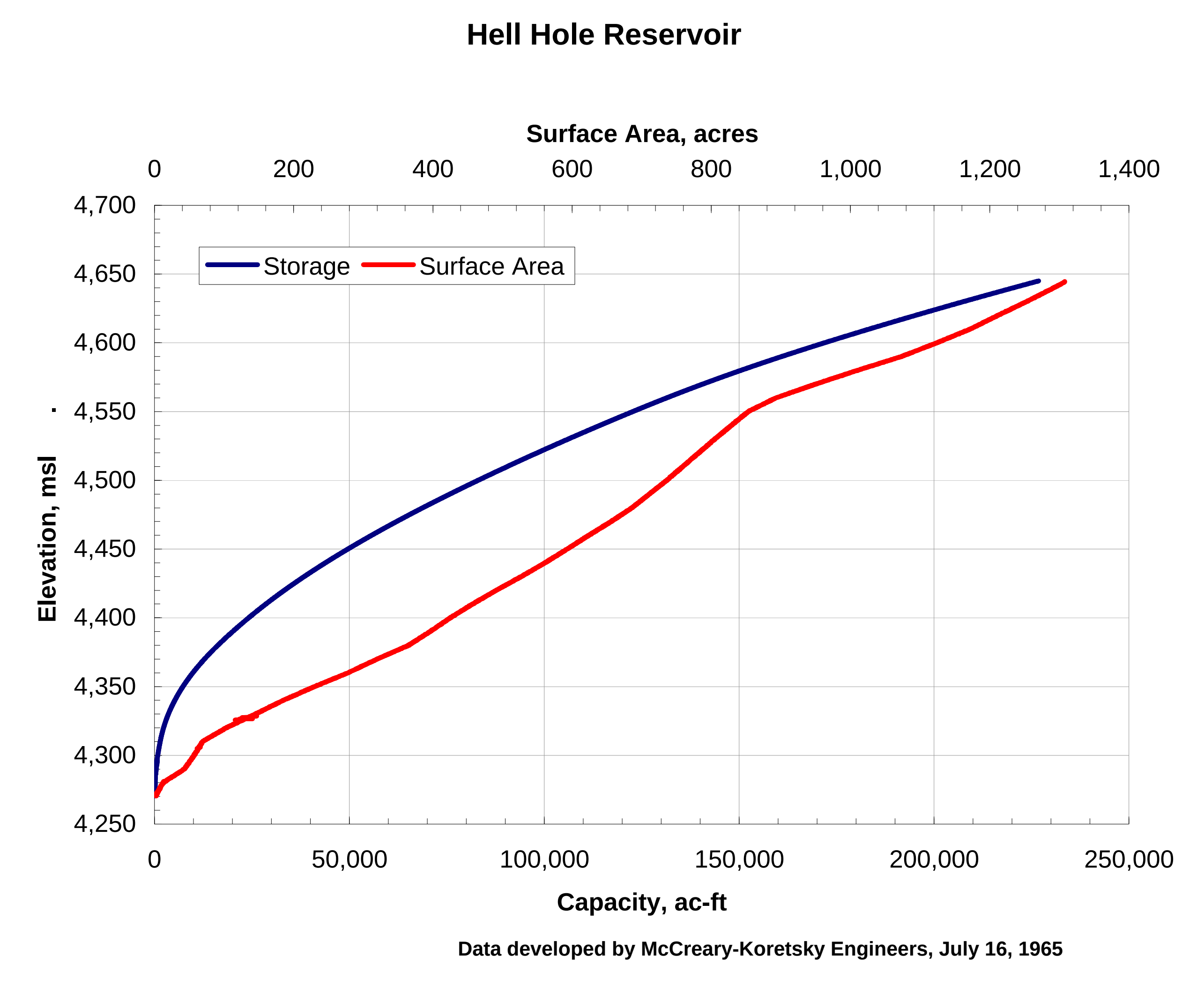


Figure 7.3-11. Ralston Afterbay Storage Capacity Curve.

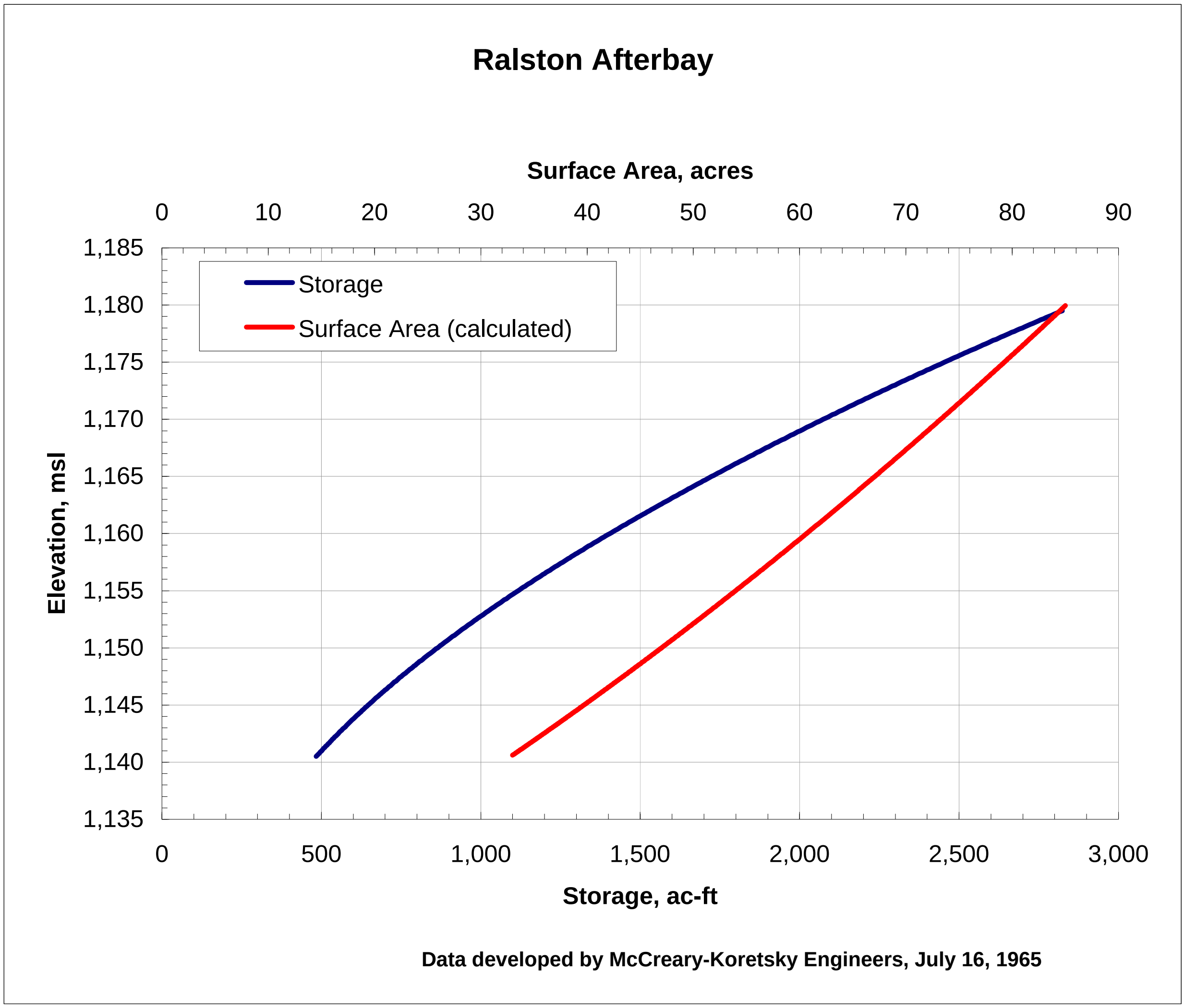


Figure 7.3-12. Middle Fork Interbay Storage Capacity Curve.

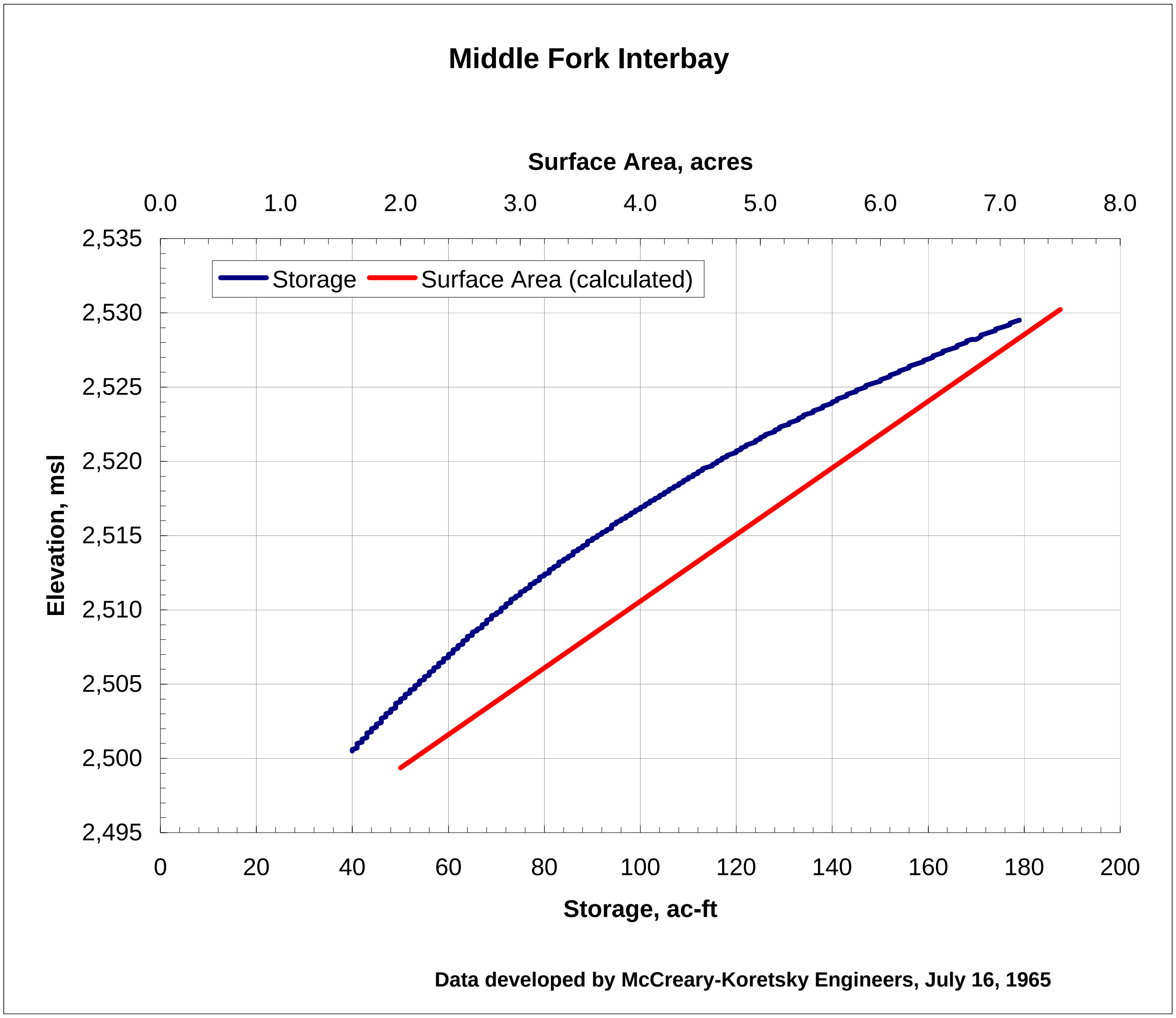


Figure 7.3-13 Duncan Creek Diversion Impoundment Storage Capacity Curve.

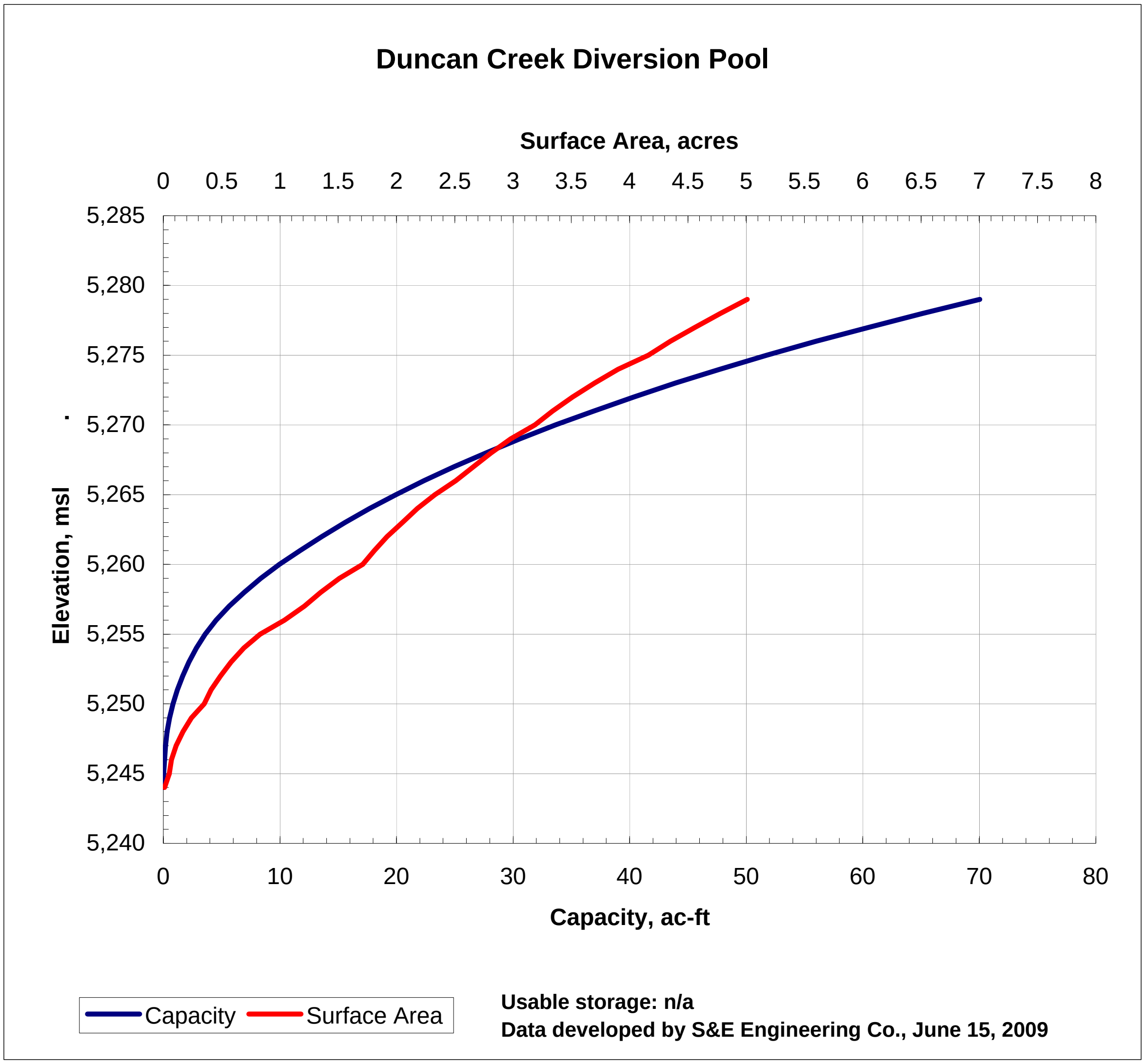
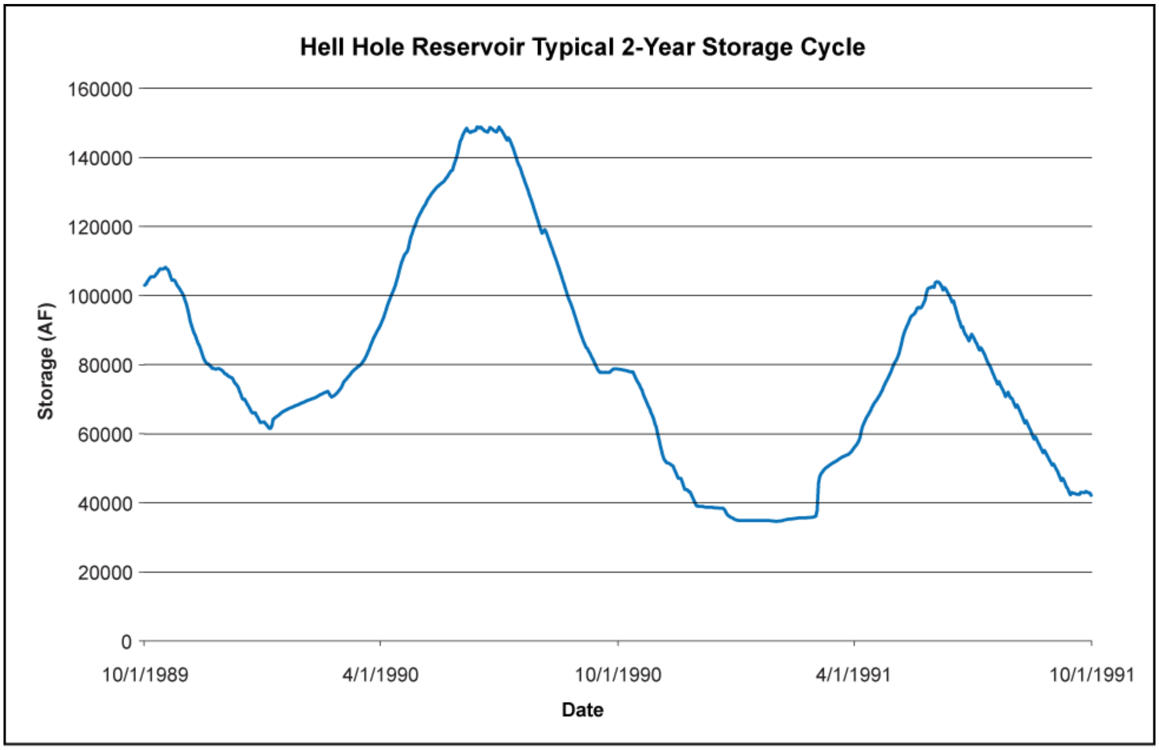


Figure 7.3-14. Hell Hole and French Meadows Reservoirs Typical 2-year Storage Cycles.



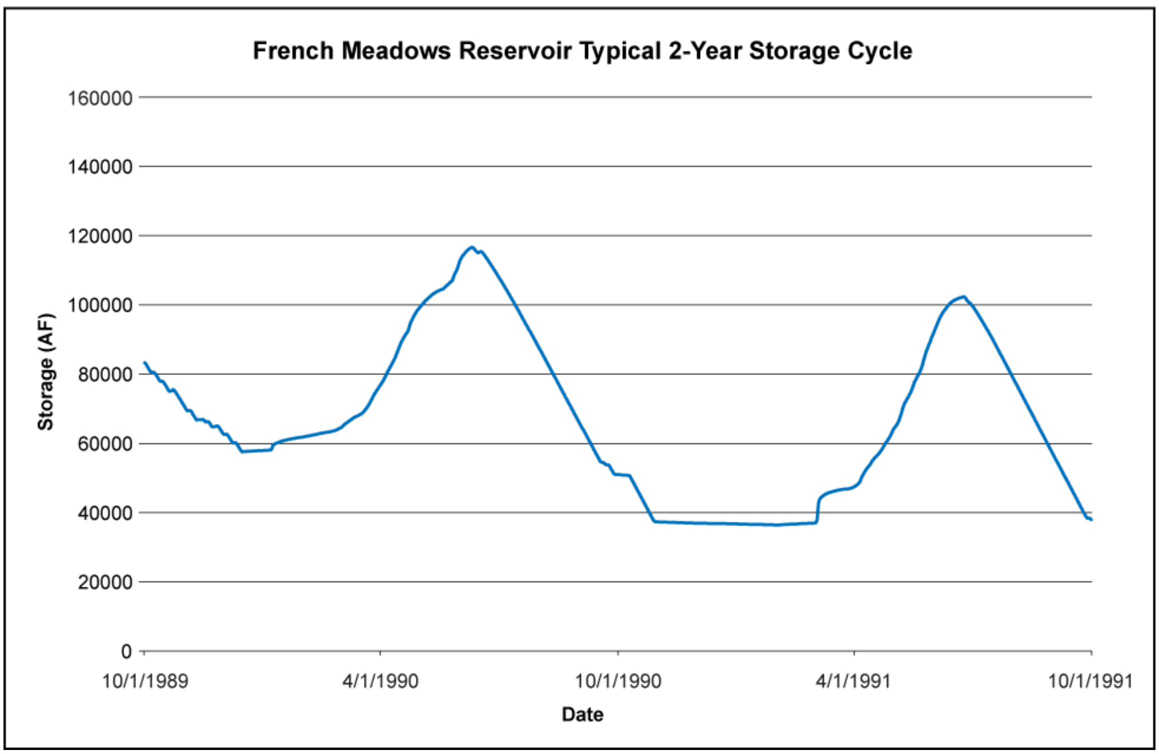


Figure 7.3-15a. Flow Releases and Reservoir Storage at Hell Hole Reservoir (1975 - 2007)

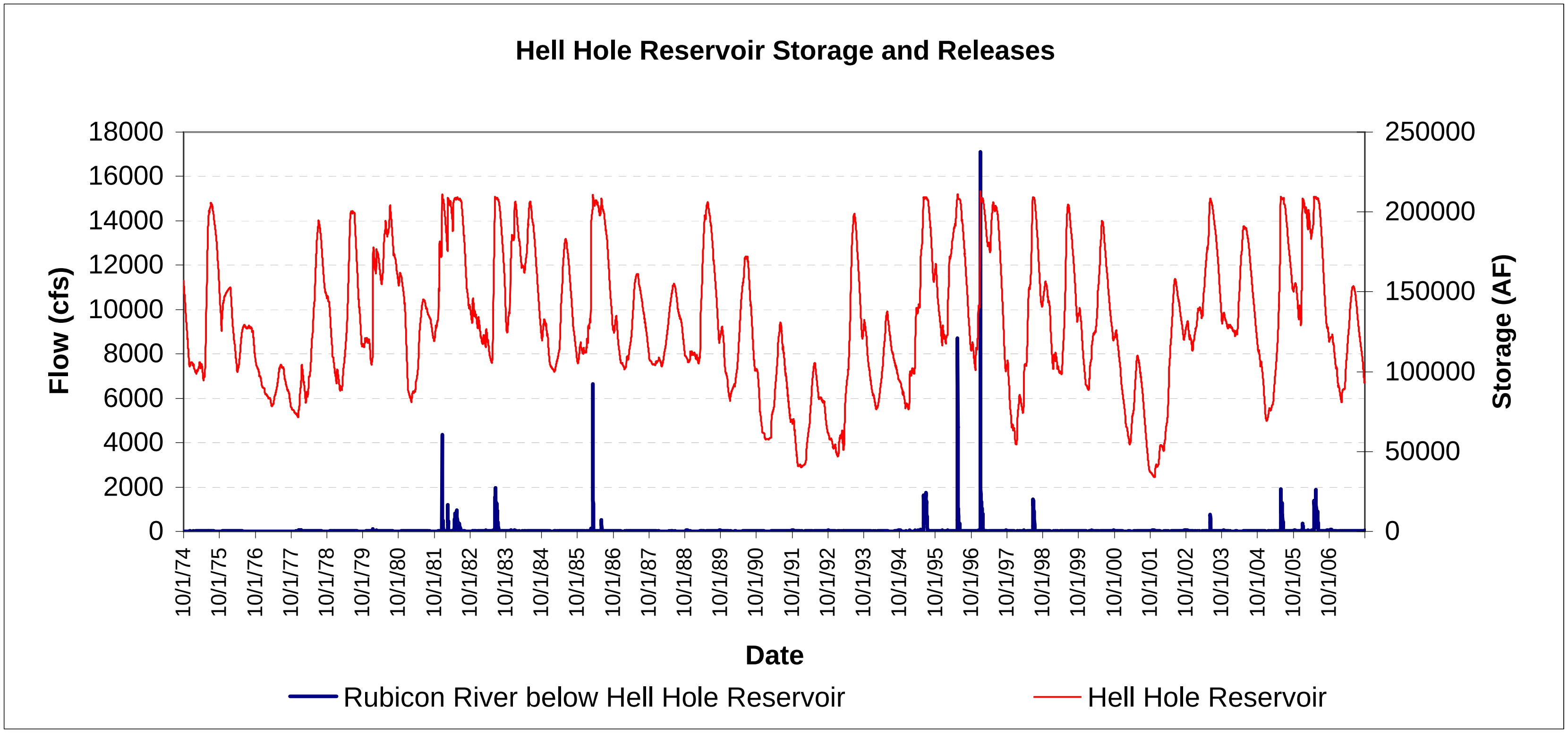
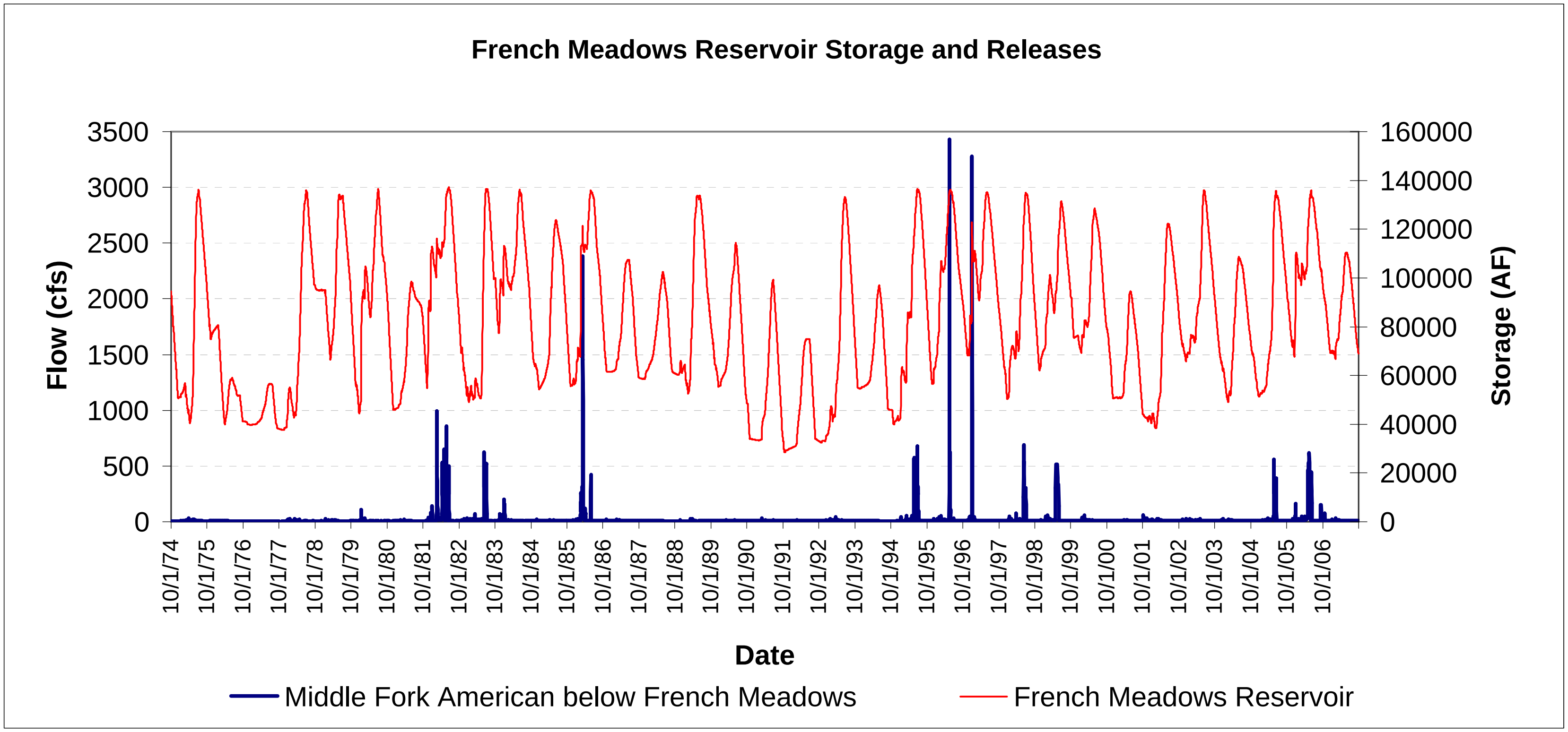


Figure 7.3-15b. Flow Releases and Reservoir Storage at French Meadows Reservoir (1975 - 2007)



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